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ABSTRACT

The purpose of this study was to evaluate college student attitudes toward the PHOENIX computer-based education system and to gauge the instructional effectiveness of computer-assisted instruction (CAI) achievement and testing in a variety of disciplines in a university setting. Data for the study were obtained from 400 students enrolled in five courses (52% male, 48% female), who answered questionnaires concerning their attitudes toward the operation of the computer terminals, ease of system use, effectiveness of the instructional system for retention of course materials, pre- and posttest achievement scores and gains, value of time spent on the system, and preference in examination delivery format. Results indicate that: (1) the majority of the students felt the PHOENIX system was worthwhile; (2) all of the students who were given an option to use PHOENIX did so to some extent; (3) 81% said the time delay in using the system was a problem; (4) 63% said the use of PHOENIX should be a required part of the course in which they were enrolled; (5) over 27% experienced some problems with the visual display even though eye strain or fatigue did not appear to be a major problem for students in the study; and (6) 86% said the system was very beneficial and judged it to be more useful for obtaining new information than traditional textbooks. Twelve guidelines for incorporating CAI into the university are provided. Appendices include a sample PHOENIX evaluation questionnaire, raw data from the study, and a 21-item bibliography. (JB)

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Effectiveness of Computer Based Education: The UNC Phoenix System

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CHAPTER I

INTPODUCTION

A variety of research studies have been completed on computer based education(CBE). Many of these have addressed the problem of process, specific application and unique utilization. Few, however. have looked at the problem of educational effectiveness. This research is a compilation of previous research on CBE effectiveness and of the experimental findings of a staff study done at the University of Northern Colorado on PHOENIX, the mainframe system in use at the University. (PHOENIX was created by Goal Systems International of Columbus, Ohio). The data generated for this study was obtained by using the information that was stored in the archives of the PHOENIX system as students took lessons and from instruments completed by them.

THE PROBLEM

Many types of computer application are found in the field of education. Drill and practice, games, test generation, educational management, tutorial presentation, etc., are examples. Only a few applications address the problem of instructional effectiveness while many have addressed the attitude of students toward computer-based instruction (CBI) or computer-assisted instruction (CAI).

In a synethesis of research on computer-based instruction sponsored by the National Science Foundation, Kulik drew five major conclusions from his meta--analysis of fifty-one previous research studies (Kulik, 1983).

These conclusions are as follows:

1. CBI can improve student learning. The average effect is to raise student test scores from the 50th percentile to the 63rd percentile.

2. Student attitudes toward the subject being learned and student ratings of the quality of instruction are slightly more favorable with CBI.

3. In contrast, students' attitudes toward computers are strikingly more positive as a result of CBI.

4. CBI has been reported as saving anywhere from 30 percent to 88 percent of student learning time.

5. Because of the rapid change in computer technology and classroom use of computers, these findings do not necessarily predict future results.

As a result of this evidence and based on the conclusions reached by Kulik in his analysis of previous research, it was deemed wise to study the application of computers across subject disciplines to see if expected variations exist across subject fields. This was done specifically for a large mainframe delivery system called PHOENIX which is in use in many higher education institutions and private industries. The study was also prompted by the fact that many of the research studies evaluated by Kulik were concerned with the microcomputer instead of the mainframe system and dealt with the curriculum areas of mathematics, computer literacy, foreign language and special education. Little data was available on 'lab type' courses.

PURPOSE OF THE STUDY

The purpose of this study was to evaluate the students attitudes toward computer based education and to gauge the instructional effectiveness of CAI achievement and testing in a variety of disciplines and educational settings within a university. More specifically, the study attempted to answer the following questions.

1. How much time does a student spend on the PHOENIX Computer Based Education System for a given class and in which modes of operation?

2. What attitudes are held by students toward CBE who have had experience on the PHOENIX mainframe system?

3. Are the attitudes of students in a free vs. a controlled environment regarding the PHOENIX system?

4. Are students who use Computer Based Education fearful of terminal operation and the system in general?

5. How does terminal availability effect CBE operation and course/student assignment?

6. What are the implications for response rate from the computer to the students attitude toward the CBE system?

7. What elements of screen design influence the interaction of students who utilize CBE?

8. What psyciological factors such as eye fatigue effect the operation of a CBE system from the students point of view?

9. Should the use of PHOENIX for supplemental instruction be required or optional at students request?

10. How do students rate CBE for initial contact learning of new information and course concepts?

11. What factors control the average time spent on the system by students for CAI, and testing in a normal university course?

DEFINITION OF TERMS

For the purpose of this study, the following terms are defined as they were used in the discussion and data presentation:

CAI -- (Computer Assisted Instruction). The direct use of a computer for facilitation and certification of learning -- that is, using the computer to make learning easier and more likely to occur (facilitation), as well as using the computer to create a record proving that learning has occurred (certification). Primarily concerned with the delivery of a tutorial lesson with appropriate feedback to establish mastery learning through a response mode.

CBE -- (Computer Based Education). The generic term used in literature and writing to indicate the application of a computer for delivery and record keeping which includes both CAI and CMI applications.

CMI -- (Computer Managed Instruction). The systematic control of instruction by a computer. It is characterized by testing, diagnosis, learning prescriptions and through record keeping.

COGNITIVE ACTIVITIES -- Activities related to learning and the subsequent use of specific facts, procedures, decisions skills, etc. Mental or verbal activity as opposed to manipulative of psychomotor activity.

CONVENTIONAL (TRADITIONAL) INSTRUCTION -- Presentation of educational information by an instructor to more than one student at a time using lectures, discussions, demonstrations and performances in a classroom.

CRT -- (Cathode Pay Tube). The television type screen used to display pictures and characters. Sometimes called Video Display Terminals (VDT).

CUSTOM SOFTWARE -- Tailor-made computer programs prepared for a specific purpose. Contrast the packaged software, in which the programs are written in advance, usually for general purposes by professional programmers.

DEDICATED -- If a computer or piece of hardware is assigned exclusively to one task, it is said to be dedicated system. In this study, PHOENIX used terminals that were a dedicated system for CBE utilization only.

EDUCATIONAL TECHNOLOGY -- The applications of principles of modern behavioral science and technology to support and enhance the program of education.

HARDWARE -- The electronic circuits, memory and input/output components of a computer system; the "tangible objects".

INPUT DEVICE -- Any machine that allows entry of commands or information into the computer. An input device could be a keyboard, tape drive, disk drive, microphone, light pen, digitizer or electronic sensor. The input/output devices used in this study were IBM 3278 and TELEX CRT terminals.

INSTRUCTIONAL STRATEGIES -- The series of decision structures, such as pacing, difficulty level, readability level, etc., which determine the dynamic nature of instruction. Usually controlled by an instructional model.

INTERACTIVE -- Commonly used to describe software programs that provide give and take between the operator and the machine. The program may ask a question to elicit a response from the operator or present a series of choices from which the operator can select. Also referred to as conversational mode. Student input to the PHOENIX system in this study was in this context.

KEYBOARD -- The panel of keys which is connected to a computer and used to enter data. It looks similar to the keys on a typewriter.

MAINFRAME -- The largest of computers. With an expansive internal memory and fast processing time, costs range from the hundreds of thousands of dollars up.

MICROCOMPUTER -- A small but complete microprocessor-based computer system, including CPU, memory, input/output (I/O) interfaces and power supply which cost around $2,000.00.

MINICOMPUTER -- A small computer, intermediate in size between a micro-computer and a main frame computer.

MULTI-USER -- The ability to have more than one person using the resources of the computer at one time. IT requires multi-tasking or multi-processing.

PASSWORD -- A (secret) identification code keyed by the user and checked by the system before permitting access. Each user or group of users has a unique password.

PROGRAMMED INSTRUCTION -- A student-centered method of instruction which requires the student to make active responses to instructional materials, provides immediate confirmation of the student's accuracy, allows the student to progress at his/her own rate, and is tested and revised before display on the basis of student response.

RESPONSE TIME -- The time required for the system to accept an input and respond visually on the monitor so the operator can judge the result of that input. The time required for the operator to get, an answer from the system.

SELF-TEST -- A procedure whereby a system checks the correctness of its own operation. In the PHOENIX system, students grades, scores and responses are evaluated by the program and recorded/answered accordingly.

SIMULATION -- A computerized reproduction, image or replica of a situation or set of conditions. A program which emulates realistic condition or circumstance.

SOFTWARE -- A general term for computer programs and documentation involved in the operation of the computer. The instructional programs and test files within the PHOENIX system are examples of software.

SYSTEM -- Usually refers to a group of related hardware and/or software designed to meet a specific need. PHOENIX and its operational programs with tutorial lessons and test files are a system.

TERMINAL -- A keyboard plus a CRT and/or printer that can be connected to a computer. The terminals of the PHOENIX system are video outputs similar to the TELEX or IBM 3278 model display units.

LIMITATIONS OF THE STUDY

Because of the confusion associated with Computer Based Education (CBE) and the problems which might exist in interpreting data and procedures for this study, the following restrictions and limitations were employed.

1. The students participating in the study were those who by chance registered for the courses during the quarter in which the study was undertaken. No attempt was made to establish experimental or control groups within each class nor were there attempts to match members between classes.

2. The data collected from PHOENIX and used in the study were tabulated from the internal programs already existing within the PHOENIX system when purchased from Goal Systems International. No attempt was made to customize the data collecting procedures within the system for this study.

3. Attitude toward the system and the programs incorporated in the study were obtained from an information response form created specifically for this study. The form contained approximately 35 items of demographic and fixed response structure with space provided for individual comment from each participant.

4. The data was collected from courses in Microbiology, Oceanography, Computer Based Education, Physical Education and Digital/Microprocessor Fundamentals. No attempt was made to purposefully establish or select a variety of courses other than to use all classes offered during the fall quarter who had programs written for the PHOENIX system.

5. In the case of Microbiology, only the CMI portion of PHOENIX was used to help tutor or instruct the class. All of the other classes had both tutorial (CAI) and test (CMI) programs available to the student.

6. The data collection extended over a two quarter time period, summer and fall quarters, 1984.

7. All graphic materials utilized in the study were obtained from diagram books located at each terminal or available from the circulation desk in the library. Only limited graphic displays were available from the terminals due to the alpha-numeric nature of the IBM 3278 terminals.

8. Data for the study was obtained from students 18 years of age and above. No attempt was made to study students below the college age level. Also, students in the program were indicative of the average UNC student which represents a select group and not an open enrollment system.

CHAPTER II

Review of Literature

A number of studies have been completed on computer based education of the last 15-20 years. They deal with a variety of emphasis areas from B. F. Skinner's programmed instruction format for presenting information to more recent research on screen design. A number of research studies addressed delivery structures such as drill and practice, simulation, games, tutorial interactions with a few looking at diagnosing learning difficulties and prescribing remedies. Other applications involve record keeping of student progress and testing procedures or delivery systems.

In reviewing the literature it was apparent that computer based instruction was the predominant term used to identify delivery systems related to computer applications in education. In order to eliminate any confusion in terminology, computer based instruction (CBI) will be used as a synonym for computer based education (CBE).

A search of the literature identified four major outcomes for the educational applications of computers. It is in this context that the materials in this chapter will be reviewed and reported (Kulik, 1983).

LEARNING

Much of the research related to learning and achievement was designed to find some of the benefits of CBI for students and teachers. Studies dealing with making learning more comfortable for students, faster learning, automatic measurement during the learning process, personalized tutoring, improving the quality of materials and addressing the issues of problem solving were found. For teachers, studies which reduced the drudgery for teachers in grading,

reductions in repetitive presentations in individualized environments, ease of upgrading instructional materials, more accurate documentation of student progress and providing more time for teacher-student personal contact in the process is another classification. Most of the early studies looked at these and similar problems in the hope that valid data could be generated to make sound educational decisions about CBI. As such, many research efforts were evaluation studies each dealing with some specific element of CBI. One major problem in this type of research was the lack of synthesis of previous research to get an overall feeling of the results of these collective studies. Another serious problem was the fact that each of the studies was never a direct replication of a previous research study so outcomes and conclusions could not be directly verified. Many of the CBI studies differed in design, educational setting and types of computer applications investigated. The result is an accumulation of specific outcomes which must be analyzed in detail to glean overall meaning.

The first systematic and comprehensive synthesis of previous research in CBI was conducted by Vinsonhaler and Bass in 1972. This study looked at 10 previous studies and concluded that computer delivery did produce an achievement gain in learning from one to eight months when compared to traditional instruction. These studies were primarily drill and practice in nature and involved elementary school children (Vinsonhaler, et. al., 1972).

A study by Edwards reviewed previous research which centered on CBI at various educational levels and in a variety of disciplines. They also reached positive conclusions regarding the use of computers for learning. One of the most significant was the reduction in learning time when computers were

utilized in instruction. Studies of this nature were identified as "meta-analysis" studies undertaken to get a synthesis of what was really known about the CBI process.

This concept of meta-analysis was used by Hartley in 1977 for mathematics and by Glass, McGaw and Smith in 1981 for evaluation. Burns and Bozeman in 1981 used this meta-analysis technique to find that computer based tutorials raised achievement test scores by .45 standard deviations and that computer based drill and practice raised test scores by .34 standard deviations. It was found that little relationship existed between experimental design features and study outcomes.

In 1980, Kulik, Kulik and Cohen found that college students raised their examination scores by .25 standard deviations and caused an increase in the positive attitudes of students toward CBI and the subject being studies. In 1981, Kulik did a meta-analysis and focused on research over a wider range of grade levels and subject areas and covered a wider time frame than previous efforts. It was one of the most comprehensive attempts for bringing together data about CBI ever attempted and covered 51 studies. It looked at computer applications in drill and practice, tutorial delivery, computer managed teaching, simulation and computer programming for problem solving. The studies analyzed differed in experimental design, publication history and course setting.

The findings of Kulik's study indicated that achievement test scores for the CBI group was higher than for the control group in 80 percent of the cases. In 25 studies which reported a significant difference between the experimental and control groups, 90 percent showed that the CBI group received

higher test scores and that the average gain was .32 standard deviations. In test terms, scores were raised from the 50th percentile to the 63rd percentile.

ACADEMIC ATTITUDES

Based on the analysis of data in CBI studies, computer based teaching had only a small effect on the attitudes of students toward academics. As reported by Kulik, only ten studies showed results of student attitudes toward the course area. Of these, eight sighted a more positive attitude toward the course as a result of experiencing CBI. None of the studies reported a significant difference in the student ratings although most were positive in nature.

ATTITUDES TOWARDS COMPUTERS

Although only four studies addressed the attitude of students towards computers, the results indicated that students who experienced CBI were found to feel more positive toward computers than those students who were not familiar with them. Three of the studies indicated a significant difference in attitude with a .61 standard deviation gain noted. This was considered a moderate difference and noteworthy.

A study done by Burns in 1983 found that student attitudes towards CBI improved, the materials that were taught were retained by the students and that the learning time for obtaining the material was also reduced (Burns, 1983). In analyzing most of the research on CBI it is evident that the greatest utilization and contribution of CBI can be made if it is used as part of a comprehensive program which used the computer to do what it does best, manage learning and deliver specific information and not replace the teacher who contributes the socialization essential to effective learning (Jelden and Brown, 1982).

INSTRUCTIONAL TIME

Only two studies were identified by Kulik which could be analyzed for time comparisons. In one study, students had a 39 percent time savings by using CBI over traditional instruction. In the other study, students had an 88 percent time savings over traditional study. These gains were thought large enough to be reported as evidence in favor of CBI over traditional instruction.

Since the analytic studies completed by Kulik, a number of other individual research efforts have been completed on specific issues in CBI. One done by Kiesler in 1984 raised the issue programming people in the exchange of information using computer delivery as opposed to educating them and suggested that CBI might create tunnel vision in thinking (Kiesler, 1984).

Several other studies supported previous research which concluded that achievement gains using CBI were greater than that found in traditional instruction (Andresky, 1983 and Ortman, 1983). Research on the effectiveness of CBI supported the conclusion previously reached by indicating that the greatest impact on learning using CBI was knowledge gain (Davis, 1983). Further, technical education using CBI placed graduates on the job sooner than traditional instruction (Meyer, 1983). Broussard found a significant improvement in student study skills and academic attitudes when CBI was employed in the learning experience (Broussard, 1983).

Although most CBI studies dealt with the development and gain of knowledge, several have found that skill can also be improved with computer delivery systems (Baldwyn, 1983). The gain was achieved with gifted students in a rural, small school setting. On the other extreme of the educational setting, Myers found that students who needed remedial education in college could increase learning gains using CBI and at the same time decrease costs.

CONCLUSIONS

The conclusions drawn from previous research which utilized the meta analysis technique as reported by Kulik are these:

1. CBI can improve student learning to a significant level, from the 50th percentile to the 63rd percentile.

2. Student attitudes toward the subject being learned is slightly higher when CBI is employed in instruction.

3. Student attitudes toward computers are significantly higher when compared to traditional students.

4. CBI can save from 39 to 80 percent of the learning time for subject mastery.

Kulik also pointed out that these findings did not predict what will happen in the future or that all studies will reach these specific results. The conclusions reached were based on an analysis of previous research. Very possibly future studies may raise or lower the conclusions reached. The study undertaken by Jelden for the PHOENIX system was an attempt to collect additional data on attitudes and student achievement over a variety of subject areas and age levels in a university setting. The end result is an addition to the existing data on the effectiveness of CBI in education.

In recent ERIC report created at the Syracuse University Clearinghouse, a compilation of the history of educational technology, curriculum structures and future developments for it were presented by several authors. This compilation is very useful for determining what educational technology is, how different points of view about the subject came about and what the directions of the field are likely to be in the future. It is a very useful document for comprehending the field of educational technology and for helping to determine what the program potential for computer based education is likely to be in the near future.

CHAPTER III

Methods and Procedures

INTPODUCTION

The purpose of this study was to obtain some descriptive data on the relative effectiveness of Computer Based Education, in particular the PHOENIX mainframe delivery system. In addition to obtaining data on the instructional effectiveness of PHOENIX, an attempt was made to evaluate the student attitudes toward the computer based instructional system in general. Because this type of study required information about attitudes as well as quantitative data, several sources of information were used as input to the study. The number of students involved in the study required that data be collected over a period of time and that several different faculty be involved in the collection of this data. To this end, controls and procedures were established and followed as closely as possible to make the data for the study as valid and reliable as could be expected over the data collection period.

DESCRIPTION OF THE POPULATION

Students involved in the study were enrolled in a variety of classes at the University of Northern Colorado during the Summer, Fall, Winter and Spring quarters for the year 1984-85. This student population involved both undergraduate and graduate levels including freshman through doctoral programs. In the main, it was assumed that by using all students enrolled in the classes offered, they would be representative of the normal population and that conclusions could be reached based on the normal distribution for all college students. Data for the study were obtained from 400 students enrolled in 5 courses.

The following courses were used as model classes and were representative of both general education and major subject area fields. Courses in general education included Oceanography 110 and Physical Education 284. Major area courses included Microbiology in undergraduate Science, Computer Based Education and Digital electronics in the graduate Educational Technology program. Table 1 shows a detail listing of the enrollments and percentage of students in each program area represented by the study.

Table 1

Course	Number	Percent
Ocenography	176	44.5%
Computer Based Education	100	25.3%
Physical Education (tennis)	53	13.4%
Digital Electronics	42	10.6%
Microbiology	24	6.1%
	---	-----
	395*	100.0%

*Five bubble sheets were not clearly read by the system and were thus not processed in the statistics for class identification. The total population for the study was 400 students.

In addition to the courses identified above and the enrollments indicated, further demographic data on age, sex, academic rank, estimated grade point average and course grades were obtained. The summary of findings in Chapter 4 details this information for you.

The five courses identified above utilized 7 university faculty for instruction. Physical Education and Oceanography each had two sections taught by different faculty members. Each section did use the same classroom materials and computer programs in the study. The Oceanography course had the PHOENIX CBE materials as elective support information for the course. The Physical Education class had both instruction and testing required as part of the class procedure. This structure provided means for the comparison between classes under different course procedures.

DESCRIPTION OF THE INSTRUMENT

The information form designed to obtain the student demographic data and the attitudes of students toward computer based education was created by the researcher and pilot tested in the Spring quarter of 1984. Refinement and clarifications were made as needed and new items were added which attempted to provide information to answer the questions raised in the purpose of the study. As much as possible, all data was to be obtained in fixed type response items to remove the recording biases which might color the truthfullness of the answers. Where appropriate, explanations were requested to clarify answers. A sample of the instrument can be found in Appendix A.

Because the instrument was to obtain data on the attitudes of the students toward computer based education and to assess the value of the instructional program, the response items for each type of information were

randomly placed within the form. A total of 36 items were presented to the students for response. The first 9 items were designed to obtain demographic information and student characteristics while the remaining items dealt with the affective evaluations of the CAI materials and the instructional system.

COMPUTER DATA FROM PHOENIX

The PHOENIX computer based education system is designed to be both instructional and testing in nature. Built within the system are archive files and computational schemes which calculate the necessary information about student tries, test scores, pre-post test characteristics, time on the system, mastery criteria for all instructional lessons and other significant tabulations. It is designed to provide the student with up-to-date progress reports and cumulative scores on all tests and instructional programs. Upon completion of the courses, print-outs of this information for each student provided the necessary progress reports for the time/performance standards of each objective, lesson or test undertaken in the program. It should be mentioned that in the Digital Electronics and Computer Based Education courses, all students were required to take a pre-test prior to any instruction for the class. In this way, evidence could be gathered to document the achievement gain of students in those courses. Further information on the capabilities of the PHOENIX computer based educational system can be obtained from Goal Systems International, Columbus, Ohio or from documentation manuals for the system.

TPEATMENT OF THE DATA

The following procedures were followed in securing and assessing the data for the study.

1. Instructional programs and/or test files were created for each of the instructional areas or classes. These were validated by administering them to preceding classes and modifying where needed.

2. Students were enrolled into the classes on a first come first served basis. As no restrictions or pre-counseling were done with any of the students prior to their enrollment, it was assumed that they represented the average student enrollment and were thus representative of college students in general for these classes. All students in every class were given opportunity and encouraged to take computer lessons and/or tests on the terminals provided.

3. Oceanography and Microbiology students were given the use of computer assisted instruction as an option. The Physical Education, Digital Electronics and Computer Based Education classes were required to take the materials. In this way different types of applications could be studied and compared. All students were given a brief overview of the PHOENIX system with instructions and a student number to sign onto the system. Thirty minutes proved to be adequate for this purpose.

4. In the Computer Based Education and the Digital/Microprocessor course, all students were given a mandatory pre-test within the first week of the class prior to any instruction. The test scores for this exam were held in the archives of the PHOENIX system and printed out at the end of the quarter as the 1st test data.

5. In those courses where both instruction and testing were to take place, students were given the same ID number for both the instruction and test programs. It was necessary for these students to sign on individually to either the instruction or the test program. This procedure provided a means for keeping the test scores separate from the instruction scores and allowed some classes to use only one of the modes if the instructor so determined.

6. Periodic checks were made by the instructors on a daily basis to track student performance and to identify those who were having difficulty or to answer student messages left on the system. Students were prodded in those classes where instruction was mandatory and only observed where instruction was optional. Grammeric modifications to the program were made if appropriate but no major changes were entered in the context of the script for the lesson or tests.

7. At the end of the quarter, students were given the evaluation instrument for PHOENIX. The administration of the form and its completion by students took approximately 20 minutes per class. The students were asked to enter their social security number of the evaluation form so that the records held in the PHOENIX system could be matched with the time, GPA, age, sex, and other demographic data on the forms.

8. Also at the end of the quarter, the PHOENIX supervisor printed the cumulative data on each student in each class on a special utility program provided by PHOENIX. This report contained information on time per lesson, tries on the system, pre-post test scores, cumulative records of each students, an achievement profile on the number of lessons or tests taken and the total time on the system for each type of utilization, testing or instruction.

9. The data obtained from PHOENIX was entered into the University of Northern Colorado computer keyboard entry on a CPT and combined with the data from the evaluation forms which were put into the computer by optical scanning the sheets in the computer center. This combined data provided the total information for each student in each class and allowed the computer processing of the information obtained from both sources.

10. The statistical processing of the raw data was done with the SAS (Statistics Analysis System of Cary, North Carolina) system available within the UNC computer. A program dump of the raw data was made to check the validity of the information by column/row to make sure the entries were correct. New cards were punched where appropriate as human entry on the terminal did account for some preliminary errors.

    The SAS System software reads data values in virtually any form from cards, disk or tape and then organizes the values into a SAS data set. The data can be combined with other SAS data sets using the file-handling operations within the system. Data can be analyzed statistically and can be used to produce reports. The SAS data sets are automatically self-documenting since they contain the data values and their descriptions. Some program statements in SAS perform standard operations such as creating new variables, accumulating totals and checking for errors. The SAS program will perform simple descriptive statistics operations to complex multivariate techniques. The reporting utility prints tables with labels and calculates all variables such as means, etc., to eight decimal places.

11. The utilization of the SAS software package allowed the comparison of classes and the establishment of the interrelationships of the variables within those classes. The report of the findings for the study were obtained from the manipulation of the raw data and the final reports were created by identifying the variables to be compared. It was assumed that because the data was descriptive in nature and was therefore a general measure of actual feelings and progress, the CHI-Square procedure would be adequate for testing of inter-relationships between variables. Each of the classes and courses had means, standard deviations, minimum/maximum values and variances calculated. The comparison of mean values could this be made by the CHI-Square technique.

CHAPTER IV

Findings of the Study

INTRODUCTION

The findings of this study are presented in several sections. The first section will cover the demographic data over the population of the study. The second part will cover the attitudes of the students toward computer based education in general. The third section will deal with the students assessment of the materials used in the instructional and testing programs within the system. The last section will cover the comparisons between groups and classes which were involved in the study. Because the data is simply a collection of student responses toward the hardware and software that they used while in the course, much of the information will be presented in percentage and table form. The last section which makes comparisons between categories of students or groups represented in the study, will use CHI Square tables to make comparisons. Interpretations of the data will accompany each of the tables. The final chapter of the study will address the conclusions and recommendations which resulted from this research effort.

DEMOGRAPHIC DATA

The population of the study has already been identified in Chapter three by course. The study did involve a large number of students other than those represented by that tabulation. In several instances, students were assigned to the PHOENIX system for limited lessons or tests which took them several weeks to complete. They were not involved with the full 10 week exposure of the research period. For this reason, they were not involved with the final tabulations of this study. Table 2 below identified the total number of students who were exposed to the PHOENIX system during the research period.

Table 2

Population of the Study

	Number
Number with full data available	400
Students with incomplete data	202
Total students on PHOENIX	602

The students in the study were about equally divided in numbers with regards to sex. No actual attempt was made to seek equal representation by sex as an open enrollment for each class was expected to produce a representative division of the University population. It appears that this technique did work as Table 3 shows the distribution of the population in the study by sex. It should be pointed out that several of the forms did not have the data correctly entered and thus an assignment to one of the categories by the computer was impossible. There was 19 more males than females in the study but the proportional difference was less than 4.75% which was interpreted as not significant.

Table 3

SEX OF STUDENTS COMPLETING INFORMATION FORMS

	Number	Percent
Males	207	52.4%
Females	188	47.6%
Unknown	5	- -
	---	------
	400	100.0%

Because the population of the study involved such a large number of participants, it was expected that there would be a good range of age represented by the respondents. The assumption proved correct as students from the freshman age of 18 to the upper-graduate age of 50 were represented in the study. Table 4 below identifies the number of students by age range and the percent of population they represented. Note that the greatest number of students were in the 18 to 21 age grouping which accounted for 53% of the population. The general education classes (freshman/sophomore) contained the largest enrollments and thus represented the largest population. For example, the Oceanography courses averaged about 75 students per section while the graduate courses averaged only 25 students per section.

Table 4

AGE OF STUDENTS COMPLETING INFORMATION FORMS

Age Range	Number	Percent
18 - 21	212	53.0%
22 - 29	82	20.5%
30 - 39	69	17.3%
40 - 49	25	6.3%
50 over	12	3.0%
	400	100.0%

Mean age of the population was 23.2 years.

As part of the problem posed by the research effort, an attempt was made to see if the academically talented students did as well as those who must work hard to achieve in college. To this end, an attempt was made to determine the academic rank and grade point average of the students represented in the study. Table 5 identifies the number of students in each academic class who received instruction.

Table 5

ACADEMIC RANK

Class	Number	Percent
Freshman	85	21.6%
Sophomore	80	20.3%
Junior	43	10.9%
Senior	51	12.9%
Masters	108	27.4%
Doctoral	27	6.9%
Unknown	6	- -
	400	100.0%

Of those classified within the academic rank above, an attempt was made to see what distribution existed in grade point average for those identified in the study. It was thought that bright students may have a different perspective than students who had to work hard to achieve success in college. By classifying student according to grade point average, regardless of

academic classification, it was possible to make these types of comparisons. As identified in Table 6 below the majority of students were in the higher academic achievement ranking of 3.0 GPA or better. Any judgments made on variations of attitude and progress according to GPA should be made with some reservation as over three-fourths of the population were in the upper division of achievement. Some useful data was obtained, however, from those in the lower achievement category.

Because of the variety of classes, age levels, instructors, types of courses represented, etc., in the study, it was thought that some representation of how the students were using the computer would be useful in evaluating the responses. Some classes used just the test or CMI portion of PHOENIX while others used both the instruction and test capabilities. An attempt was made to analyze the attitudes of students who used just one capability vs. those who used all the instructional systems available to them. It should be noted that no significant difference could be detected between these groups as over three-fourths of the population in the study used both the testing and instructional features. In addition, many students did not mark either category so a valid judgment of difference could not be readily detected. Table 7 below identifies the categories and the numbers of students using each capability of PHOENIX.

Table 7

Applications of the PHOENIX System

CAI	322
CMI	342
Unknown	136

STUDENT USAGE OF THE PHOENIX SYSTEM

This section details the usage of the PHOENIX system from actual student time on the system. Because testing is a different operation than instruction, it was assumed that the time spent by students on the system in these two applications

Table 8

Estimated Test Time Spent on the Computer by Students

Minutes	Number	Percent
0-5	204	54.1%
6-10	120	31.8%
11 over	56	14.1%
Unknown	23	- -
	---	------
	400	100.0%

would be different. The data does show a distinct difference between time spent on tests and time spent on instruction. Also, to see if the students

Table 9

Actual Test Time Spent on the Computer by Students

Average Number of tries	Total Time	Average Time
27*	4 hrs - 44 min	9.86 minutes

* Each course had different numbers of lessons and tests required for the class. This is the average number of times each student registered onto the PHOENIX system to take a performance test during the 10 week quarter. These figures represent the average values for the entire population and not any specific course.

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had a grasp of the actual time spent on the system and what they thought they spent, students were asked to estimate the time for both testing and instruction that they spent when on PHOENIX. It was interesting to note that they actually spent a bit more time with computer based instruction for both testing and tutorial lesson contact than they indicated. The difference was calculated on the number of tries per test divided into the actual time on the computer in the mode concerned. Students were reasonably close to their estimated time as indicated by comparing the data between Tables 8 and 9. Table 9 gives the actual time spent by students in the testing operation.

Table 10

Estimated Lesson Time Spent on the Computer by Students

Minutes	Number	Percent
0-14	177	44.3%
15-29	141	35.1%
30-49	55	13.8%
50 over	27	6.8%
	---	------
	400	100.0%

STUDENT EVALUATION OF THE PHOENIX CBE SYSTEM

The following section will report the results of the students evaluation of the PHOENIX computer based education system as it was used in their course work. All students in the study were asked to complete an evaluation form on both the system and the programs entered into it by the instructors. This section will address only the student evaluations of the PHOENIX operating system and their attitude toward the logistics of it.

Table 12 contains the summation of responses indicated by students for PHOENIX. Although some of the respondents used only one phase of the system, (testing or testing and instruction), each was asked to indicate their feeling regarding the value of it for their educational experience. As indicated, 78.5% said that the CMI system was outstanding or very worthwhile from their point of view. An additional 17.8% judged it to be a good experience from an educational standpoint. Table 12 contains both the CMI and CAI evaluations. As expected, a slightly greater number rated the CMI section higher than the CAI program because 26 students were not involved in the CAI portion of the system. When extrapolated into the CAI evaluations, the total judgments do not significantly differ in their assessment.

Table 12

Student Pesponses Pegarding the PHOENIX CBE System

Question:

What is your best judgment regarding the value of the PHOENIX system and its programs for learning and/or testing?

CMI (Test Mode)

Pesponse	Number	Percent
Outstanding	98	24.5%
Very worthwhile	216	54.0%
Good	71	17.8%
Fair	10	2.5%
Waste of time	5	1.3%
	---	------
	400	100.0%

CAI (Instructional Mode)

Pesponse	Number	Percent
Outstanding	92	24.6%
Very worthwhile	185	49.5%
Good	76	20.3%
Fair	19	5.1%
Waste of time	2	.5%
Unknown	26	- -
	---	------
	400	100.0%

One of the things addressed in the original purpose of the study was the psychological aspects of using the computer as an instructional tool. To address this issue several questions were presented to the students. The problems involving terminal operation was one. The question and responses of Table 13 address this issue.

Table 13

Fear of Terminal Operation

Question:

Are you apprehensive about terminal operation and using PHOENIX?

Response	Number	Percent
Very much	222	55.5%
At first - not now	142	35.5%
No major problem	34	8.5%
Not at all	2	.5%
	---	------
	400	100.0%

One of the perplexing issues regarding the transition period for computer assisted instruction is the fear that novice users have towards the operation of the terminals. Many have voiced a concern that they are afraid that they will damage the system or worse yet, "the system will do something to them". In looking at the responses in Table 13, it is obvious that 55 percent of the students have at least some apprehension of terminal operation and system structure. To address this issue further, an additional question was asked

Table 14

Ease of Terminal Operation

Question:

What is your feeling about terminal operation for PHOENIX?

Response	Number	Percent
Very easy	29	7.3%
Easy	93	23.3%
Difficult at first	90	22.5%
Very difficult	188	47.0%
	---	------
	400	100.0%

regarding the "ease of the terminal operation". It was hoped that information could be obtained that would help identify what the major problems were regarding fear of the system or terminal operation. To this end, a question was asked regarding the difficulty of operation. It was assumed that a certain amount of fear is generated regarding the unknown and possibly a difficult operation. The results were in support of the concept that difficulty of operation do have some bearing on fear of use. As indicated in Table 14, 47 percent of the students indicated that the PHOENIX terminals were difficult for them to operate at first. The rest did have some concern but indicated that in time this fear or difficulty did diminish with experience.

Related to the psychological factors in computer based education, some concern was voiced about the physiological factors. Some researchers have indicated that eye problems can

Table 16

Eye Problems in Computer Usage

Question:

Did your eyes bother you as you took a lesson or test? (Is viewing the screen a problem?)

Response	Number	Percent
Yes	110	27.4%
No	290	72.6%
	---	------
	400	100.0%

result from extensive use of video terminals due to radiation or sight problems. To address part of this issue, students were asked to respond to several questions regarding screen display and eye strain. Further, it was hoped that some indication could be obtained to support the screen design characteristics of computer delivered instruction. Table 15 provides a compilation of the results regarding screen display. It should be pointed out that standard 40 character wide by 20 line.

Table 15

Suitability of Screen Design and Format

Question:

Was the screen display and format easy to read and interesting?

Response	Number	Percent
Yes	367	91.8%
No	33	8.3%
	---	------
	400	100.0%

displays were utilized as the model for screen format. Most questions were displayed in a standard multiple choice; or completion format and presented in traditional single presentations per item. As further guidelines, no complex presentations were allowed and only one basic concept per screen was provided. All questions were single item presentations with space provided for insertion of the correct answer or for the selection of the correct answer if the item was multiple choice in nature. As indicated in Table 15, 91.8% of the students felt the screen guidelines were adequate for presentation.

Another issue in question at the University of Northern Colorado operation was the adequacy of terminals for student utilization. The university administration was reluctant to provide a large number of terminals at extensive cost until some form of usage or availability could be determined. Thus, it was necessary to obtain from the students the ease with which the terminals were available to them when study was needed. The question was

Table 17

Availability of Terminals for Student Use

Question:

Were the terminals available when you wanted to take a lesson or test?

Response	Number	Percent
Yes	88	22.0%
Most of the time -- some problem	258	64.5%
No, difficult to get on the system	54	13.5%
	---	------
	400	100.0%

simply asked "Could you take a lesson when you needed to or did you have to wait for terminals to open up from existing student use?". It should be pointed out that only 13 PHOENIX terminals were available in three locations to the 600 users during the ten week period. As expected, 22 percent of the students did experience delays that were somewhat frustrating and may account for some negative feeling toward the computer based education system in general. Table 17 addresses the problems suggested on terminal availability.

Another factor in computer basic instruction is the time it takes to get information into and out of a computer. In a single terminal operation or dedicated system, response is almost immediate. When you are part of a timesharing system, delays in response can cause serious problems in delaying the learning experience or in creating a negative attitude about the use of

the system. In the study undertaken at the University of Northern Colorado, the mainframe system used for PHOENIX was an IBM 370/1130 with one of its 12 partitions dedicated to the PHOENIX system. Since this study was completed, a newer, faster system has been installed at UNC and the response rate has been doubled on the average. Therefore any negative responses which were indicated in this study have been somewhat rectified with the installation of the new AMDAL 470 system now in operation. Table 18 provides an assessment of the students opinions regarding the response time for PHOENIX on the old IBM system which utilized 13 IBM 3278 computer terminals.

Table 18

PHOENIX Computer Terminal Response Time

Question:

Was the response rate from the computer a problem in moving through a lesson or answering test questions?

Response	Number	Percent
Yes	57	14.3%
At times very slow (5-10 seconds)	268	67.0%
No major problem	75	18.8%
	---	------
	400	100.0%

Because the University of Northern Colorado was leasing the PHOENIX system at the time of the study, it was important that the system be evaluated in terms of student judgment of its worth. To this end the students were

asked to make recommendations regarding the purchase of the system. Table 19 shows that the students felt that the system was a good investment and 92.2 percent recommended its purchase.

Table 19

Validity of Phoenix as Instructional Tool

Question:

Do you feel that PHOENIX helped you enough that it should be maintained as a valid instructional tool?

Response	Number	Percent
Yes, keep and use	368	92.2%
No opinion	27	6.5%
No, drop and go back to traditional instruction and testing	5	1.3%
	---	------
	400	100.0%

Part of the evaluation process of the PHOENIX system was the students attitude toward computer based instruction in general. To evaluate this aspect, several questions were asked regarding the educational usefulness of the system. Table 20 and 21 indicate that over 93% of the students using the computer for either testing or instruction favored its use.

Table 20

Attitude Toward Use of Computer Based Education

Question:

Did you like to take lessons/tests on the computer?

Response	Number	Percent
Yes	374	93.7%
No	26	6.3%
	---	------
	400	100.0%

Table 21

Time Utilization for the Phoenix System

Question:

Did using the computer for instruction make you feel like you were wasting time?

Response	Number	Percent
Yes	28	7.0%
No	372	93.0%
	---	------
	400	100.0%

As you can see from the finding of this section of the study, students in general are favorably disposed toward the use of the computer as an effective instructional system. The university did use this information in purchasing the system and hope to continue its use in the future. The software package has demonstrated itself to be very useful for students and reasonably easy to author for instructors. As increased use is experienced, new programs and expended faculty and student participation is anticipated in the future.

ASSESSMENT OF PHOENIX INSTRUCTIONAL PROGRAMS

Part of any evaluation program for computer based education must address the issue of software. In this section, we will look at the attitudes of the students toward the instructional materials which were used in the system including the test items, support materials such as diagram books and the instructional tutorials in general. This includes the screen formats, models of presentation of the lesson materials and the structure of the tutorial.

To begin with, the PHOENIX system does not contain any provision for graphic displays as part of its operation. Any instructional material which requires drawings or diagrams must have supplemental diagram books accompanying them. To determine if this was a problem for students, they were asked to react to this arrangement as it might effect their learning objectives and outcomes. Table 22 lists the responses for all 400 students. Notice however, that only 25% of the students used diagram books with their instructional lessons.

Table 22

Availability of Diagram Books

Question:

If you used diagram books, were they adequate and handy for you to use?

Response	Number	Percent
Yes	114	28.3%
No	20	5.0%
Did not use	266	66.7%
	---	------
	400	100.0%

Although only 125 students of the 400 used the diagram books in their PHOENIX lesson, 20 or 5% said that they were not available at their terminal or that it was a problem to use them with the lesson materials. It is not significant but points out the fact that if other means of providing graphics within the lesson can be found it probably would be better to have them incorporated within the lesson internally than carried as outside support documents.

Related to the graphics utilization of the PHOENIX system was the design of the screens for the lesson/test items. Some concern was expressed over the clarity of the directions and the presentation of materials on the monitor screen. To evaluate this item from the students perspective, several questions were asked regarding the video presentations and instructional displays. Table 23 reports the results of the responses for screen directions to the lessons and test items.

Table 23

Clarity of Screen/Program Directions to the Lessons/Tests

Question:

Were the screen/program directions clear for the lesson and/or the tests?

Response	Number	Percent
Yes	389	98.0%
No	8	2.0%
Unknown	3	- -
	---	------
	400	100.0%

Table 24 addresses the objectives and Table 25 looks at the unit descriptions for each lesson or test. As indicated from the student responses, in all three instances these items were judged adequate by over 98 percent of the students using the programs.

Table 24

Suitability of Lesson Objectives

Question:

Were the objectives for the lesson and test clear?

Response	Number	Percent
Yes	391	98.0%
No	9	2.0%
	---	------
	400	100.0%

Table 25

Suitability of Lesson Descriptions

Question:

Did the course and unit descriptions give you enough information on what the course or lesson/test covered?

Response	Number	Percent
Yes	385	96.7%
No	15	3.3%
	---	------
	400	100.0%

One of the major concerns of an instructional designer for interactive tutorial lessons is the quality of the lesson material. Part of that quality is the ability of the program to hold the interest of the student and at the same time present information at a pace comfortable for comprehension. To this end, an instructional model was developed and followed to monitor this operation. Table 26 shows the responses for students regarding the instructional ease with which the program was presented. Note that over 93 percent of the students indicated that the programs did hold their interest and thus validated the process followed and the model generated.

Table 26

Interest of Instructional Elements to Student

Question:

Was the information in the tutorial and the response items adequate to hold your interest in the lesson?

Response	Number	Percent
Yes	369	93.2%
No	31	6.8%
	---	------
	400	100.0%

Related to the clarity of the materials, screen design and clearness of presentation for each of the lesson and/or test items, was the educational worth or value of the instructional materials from the students point of view. Lessons which the creator feels are valuable may be of questionable worth from the students point of view. To judge the educational worth of the materials in the eyes of the students, questions were asked regarding the value of the lessons and test items as it related to their learning experience. Table 27 and 28 indicate that 70.9 percent of the students felt the lessons were very beneficial for learning and 77.1 percent said the lessons actually helped them remember the material better than traditional lecture-discussion or text instruction.

Table 27

Educational Worth of Computer Lessons/Tests

Question:

How would you rate the worth of the computer lessons/tests in achieving the objectives and information in the course?

Response	Number	Percent
Very beneficial	283	70.9%
Contributed some	103	25.8%
No better than the text	13	3.0%
Did not help much if at all	1	.3%
	---	------
	400	100.0%

Table 28

Retention of Lesson Material with CAI

Question:

Did the computer lessons help you remember the material taught in the course better than a text or traditional lecture presentation?

Response	Number	Percent
Yes - CAI better	307	77.1%
No - test/lecture better	29	7.3%
No major difference	64	15.6%
	---	------
	400	100.0%

Although the responses do not prove that CAI is better than traditional instruction by actual number value, it does give a good representation of how the majority of students feel about the value of computer delivered lessons. It should be pointed out that for some students, this was their first confrontation with CAI and that there was some Hawthorn Effect present. If however, future studies continue to indicate that students do feel better about learning with the computer, it could become a very useful technique to increase the motivation of the students who are in the educational process.

To assess the quality of the lesson content in comparison to other traditional materials, students were asked to judge the CAI material as it compared to other support texts and lectures for the course. Table 29 lists the responses to this item. Notice that 82.6 percent rated the CAI materials

Table 29

Quality of CAI/CMI Materials

Question:

How would you rate the quality of the tutorial lessons and test items?

Response	Number	Percent
Very good	149	37.4%
Above average	184	46.2%
Average	63	15.3%
Poor	4	1.0%
	---	------
	400	100.0%

above average which does establish their value in the eyes of the student. Table 30 displays the students perception of the readability of the materials. In some courses, new terminology poses as problem for student until they become well acquainted with the course material. The CAI lessons tried to teach vocabulary in a less threatening way by providing explanations in a non threatening way as the lesson was presented in the program. In doing this, the instructional designer runs the risk of making the program boring and unimaginative.

Table 30

Readability of CAI Tutorial Lessons

Question:

Was the readability of the material suitable?

Response	Number	Percent
Yes	322	80.7%
No	78	19.3%
	---	------
	400	100.0%

The bottom line on any educational technique or process is whether or not the students actually learn more one way then another. Changes in test scores, raised levels of competency, etc., are but a few of the measures that can be used to judge this very important factor. Related to these measures is the student perception of whether they learned more with one system or the other. Table 31 lists the student perception of how they felt the PHOENIX system helped them to learn the lesson materials. Notice that 71.2 percent

Table 31

Rate of Student Learning with CAI

Question:

Did the PHOENIX lessons/tests held you learn more than traditional instruction?

Response	Number	Percent
Yes, PHOENIX raised my learning	284	71.2%
About the same as traditional	111	27.6%
No, PHOENIX held me back	5	1.3%
	---	------
	400	100.0%

indicated that PHOENIX raised their level of learning more than traditional instruction while only 1.3 percent said it held them back or had a negative influence on their learning experience.

Because PHOENIX contains both a CAI tutorial and a CMI testing component, it is possible to administer examinations formally at the end of the course or on demand by the students within the course as they determine. Students were given experience in both modes of test administration in the courses and asked to indicate which of the two methods they preferred.

Table 32

Preference for Administration of Final Exams

Question:

For final exams, would you prefer traditional teacher administered exams at the end of the quarter or monitored computer administered exams when you are ready to take them?

Response	Number	Percent
Teacher tests at end of quarter	102	25.5%
Computer tests on student demand	164	41.0%
No opinion -- either OK	134	33.5%
	---	------
	400	100.0%

Over 41 percent of the students indicated that they would rather have the final exams administered by the computer on demand than at the end of the quarter by the teacher. As part of this assessment, 33.5 percent said that either way was OK by them so only about 25 percent of the students preferred the end of quarter teacher administered tests. With the computer management systems now available to teachers and students, it is obvious that instruction can be more personalized and can fit the needs/demands of students. Provision for special learners and accelerated study can be handled on the same system with no inconvenience to the instructor.

As an author creates an instructional program, he/she strives to make the instruction as personal as possible. The use of words and phrases which appear to directly address the user as an individual is purposely done. To see if the programs and instructional materials accomplished this goal, students were asked to respond to this issue. Table 33 shows the responses of the students.

Table 33

Personalization of Lesson Material

Question:

Did you feel that the lessons were personalized enough for you?

Response	Number	Percent
Yes	310	77.5%
No	22	5.5%
No opinion	68	17.0%
	---	------
	400	100.0%

Note that over three fourths of the students felt they were actually engaged in conversation with the computer and felt that the instruction was for them as an individual.

Because students were given an option of using the PHOENIX system or traditional texts in some classes required to use the CAI system in other courses, it was thought advisable to ask them if PHOENIX should be required or optional as part of the instructional program. The thought was that those who

may have had negative reactions to the CAI system might still feel that although they didn't like it, the system was still beneficial to them from an educational viewpoint. Table 34 identifies the feelings of students regarding the use of PHOENIX as a required or optional system for them.

Table 34

Utilization of the Phoenix System

Question:

Should the use of PHOENIX for supplemental instruction be required for class instruction or should it be make optional at student request?

Response	Number	Percent
Required -- good help to me	253	63.2%
Good experience but not much help to me	16	4.0%
Optional -- preferred to learn another way	81	20.3%
No opinion -- could live with it either way	50	12.5%
	---	------
	400	100.0%

Notice that 63.2 percent said that PHOENIX should be a required part of the instructional program. Although this response was a sign of good support for the system, it was still not of the value to require it for all students. The result is that it is strongly suggested for students who may be having difficulty picking up the lesson materials but the student is the one who must finally decide to use it or not. This finding does show that the majority of students do respond positively toward CAI as a valid and useful instructional system for learning.

To address the issue of CBE in general, students were asked to indicate if they felt CAI was useful for obtaining new information or for supplementing traditional instruction. The responses in Table 35 indicate that 86.1 percent of the students felt that CAI was very beneficial for them as learners and suggest that it be used as a supplement to traditional instruction.

Table 35

PHOENIX Value for Learning New Information

Question:

In general, how would you rate the use of computers (PHOENIX in particular), for learning new information?

Response	Number	Percent
Very beneficial	344	86.1%
No better than traditional systems	50	12.4%
Not as good as traditional texts/materials	6	1.5%
	---	------
	400	100.0%

Because some interest was shown in the value of the CAI system and the responses of student who may be of different learning abilities, students were asked to rate their ability to learn according to 4 distinct categories. The ratings and categories are listed in Table 36. Notice that 75.7 percent of the students in the study rated their learning ability as above average or very high. The students evidently see themselves as a cut above the average and have confidence in their ability in regards to learning.

Table 36

Student Learning Ability

Question:

How would you classify your learning ability?

Response	Number	Percent
Very high	90	22.3%
Above average	213	53.4%
Average	91	22.8%
Must work very hard to learn	6	1.5%
	---	------
	400	100.0%

One last bit of information obtained from the students was their reaction to the amount of time they spent studying and using PHOENIX and their judgment of how well that time was used. To address this issue, students were asked to compare the amount of time spent studying in traditional courses with the amount of time spent on PHOENIX courses. It was understood that some courses do require more time than others but the questions were worded to allow the student to make a comparison of courses and time spent using PHOENIX vs. traditional instruction. As shown, 41.1 percent of the students spent more time studying with the PHOENIX systems than they would have with traditional instruction. This provides for an interesting observation. Although they did spend more time with the PHOENIX system in studying for the course, the students in general liked the time spent on PHOENIX better than in traditional

instruction. This assessment has a lot to say about the motivation of students in traditional instruction and provides information to teachers to begin to utilize the CAI system for the improvement of the educational process. Students seem to make the transition very easily.

Table 37

Time Spent on PHOENIX vs. Traditional Instruction

Question:

Did you spend more time studying when you used PHOENIX than in other classes with traditional instruction?

Response	Number	Percent
More time with PHOENIX	165	41.1%
About the same time	137	34.3%
Less time with PHOENIX	98	24.6%
	---	------
	400	100.0%

PHOENIX RECORDS OF STUDENTS USING THE SYSTEM

Because the PHOENIX system was able to keep actual records of student progress and time usage, the following section summarizes the records kept by the system for each student participation in the study. The values are averages based on recorded data of all 400 students participating in the study. It is thought that this type of data might help plan system application and future usage as time-per test/lesson and course utilization can be estimated as new courses are added to the system. The time period

involved with the collection of this data was for a 10 week quarter system and for courses which generated 3 quarter hours of credit for the students.

RELATIONSHIPS BETWEEN VARIABLES IN THE STUDY

Because of the variety of classes and the size of the study, it was possible to identify some relationships between groups. The demographic data obtained from each student on the information forms and progress records obtained from PHOENIX provided the raw data for establishing these relationships. The following tables and explanations look at the relationships in detail. If the factors compared were not significant, an explanation of the data will be made with no table provided. If the factors did prove to be significantly related as determined by a CHI Square computation, the table will be provided and an interpretation made.

One of the first questions considered was the matter of grade point average of the participants in the study and the relationship of this value to age. It was assumed that the older students would do better than the young ones as maturity should be a bit more important in controlling the motivation of students. Also, most of the older students were in the graduate program and as such represented a select group of college students. Tables 38 provides the data for the age distribution and the estimated grade point average earned by the students in the study.

Table 38

Mean Values for PHOENIX Use

Actual time spent on each lesson	29.15 minutes
Actual time spent on each test	15.05 minutes
Estimated lesson time by student	17.76 minutes
Estimated test time by student	6.29 minutes

Total LESSON time spent on each course	6 hrs. 6 minutes
Total TEST time spent on each course	4 hrs. 31 minutes
Total CBE time for each student per course	9 hrs. 44 minutes
Average number of CAI sessions per student	18.4 entries
Average number of Test sessions per student	42.5 entries
Average total number of entries per student	59.4 entries
Average age of the students in the study	22.22 years
Youngest age of student in the study	18
Oldest age of student in the study	50
Average course grade for students in class	3.30 (B+)
Average estimated GPA of students in study	3.17 (B)
Average GPA gain for CBE students in study	.13 GPA
Average pre-test score for total group	63.3%
Average post-test score for total group	93.8%
Average achievement gain per student/course	25.1%
Average pre-test for experimental group	53.28%
Average post-test for experimental group	87.59%
Average achievement gain for exper. group	34.31%

As indicated in the table, the grades for older students were significantly higher than those for the younger students. As computed by the CHI Square formula the level of significance was beyond the 1 percent value. It should be pointed out that 52.4 percent of the students in the study were between the ages of 18 and 21. Even in this group, over 42 percent had GPA's of B or better. The students over 30, with three exceptions, had grades of B or better. This tends to follow the grading patterns of most graduate schools which establishes that grades of C in the graduate program are unsatisfactory and at UNC are rarely given.

To see this relationship a bit more obviously, a CHI Square table was generated by GPA and class level. Table 39 displays the number of students with A's, B's, etc., by freshman, sophomore, junior, senior, MA and Ph.D. level. As expected, the computation for the levels of significance were again higher than the 1 percent level.

Table 39

Grade Point Average by Age Distribution

Grade Point Average	Age Range 18-21	22-29	30-39	40-49	over 50	Total	Percent
3.5-4.00	25	38	50	16	6	135	34.80%
3.0-3.49	66	19	15	8	5	113	29.20%
2.5-2.99	65	16	1	1	0	83	21.45%
2.0-2.49	42	5	1	0	0	48	12.40%
Below 2.00	5	2	1	0	0	8	2.07%
Total	203	80	68	25	11	387	
	52.45%	20.67%	17.57%	6.46%	2.84%		100.0%

Frequency Missing = 13

Because of the high number of grades at the B level or higher, students were asked to rate themselves in relation to how hard they had to work in order to obtain passing grades in the program. Table 40 shows the distribution of GPA in relations to the students judgment of effort needed to receive good grades. In looking at the table, you can see that students that rated themselves has having excellent learning ability did in fact receive better grades. Twenty-one students did accumulate GPA's of C or below even though they rated themselves as having a high learning ability. As might be expected, 52 percent of the students in the study rated themselves as above average in learning ability. Of these 23.8 percent were receiving GPA's below

3.0. This implies that about 25 percent of the students felt they could do better or they were poor judges of their actual learning abilities.

Table 40

Grade Point Average by Class Distribution

Grade Point Average	Class							
	Frosh	Soph	Junior	Senior	M.A.	Ed. D./Ph.D.	Total	Percent
3.5-4.00	15	6	7	10	76	19	133	34.91%
3.0-3.49	33	24	11	11	23	8	110	28.87%
2.5-2.99	17	23	17	23	2	0	82	21.52%
2.0-2.49	15	23	5	4	0	0	48	12.60%
Below 2.00	1	2	0	0	5	0	8	2.10%
Total	81	78	41	48	106	27	381	
	21.2%	20.3%	10.6%	12.4%	27.7%	7.8%		100.00%

Frequency missing = 19

Although the values were not significant at the 5 percent level of confidence, (computed to the .07%), the values did show a very close judgment on the part of the students toward their GPA and their rated learning ability.

To follow up on the learning ability rating a bit further, comparisons were made between the students rated learning ability and the grades received in the courses taken in the computer based education program. The Chi Square

value was computed and the value well below that set as significant. The conclusion is that the rating of students learning ability and the grades received in the course had no significant relationship to each other.

Because a variety of classes were represented in the study and records kept allowed the comparison of age, grade classification and other variables, group means were computed on several factors to determine if students in any one category or classification in the study were significantly different from any other category. For example, evidence on differences in time spent on the system, pre-post test scores, achievement gain, average time on the system, total number of tries per lesson test were all tabulated. Table 42 characterizes the difference according to class assignment.

Table 42

Grade Point Average by Learning Ability

GRADE POINT AVEPAGE	LEARNING ABILITY					
	VERY HIGH	ABOVE AVERAGE	AVERAGE	MUST WORK HARD TO LEARN	TOTAL	PERCENT
3.5-4.0	38	73	24	0	135	34.9
3.0-3.49	29	60	22	2	113	29.3
2.5-2.99	9	46	26	1	82	21.2
2.0-2.49	10	21	15	2	48	12.4
Below 2.0	2	4	2	0	8	2.2
TOTAL	88	204	89	5	386	
	22.8	52.8	23.1	1.3		100%

Frequency Missing = 14

Table 42

Mean Values for Variables by Class Assignment

Variable	Fresh	Soph	Junior	Senior	M.A.	Ed.D./Ph.D.	Total Group
Pre-test scores	70.4	73.2	55.8	72.6	54.0	53.7	63.3
Post-tests scores	90.7	91.5	88.5	90.1	87.6	87.6	89.8
Achievement gain	11.6	12.5	15.5	16.2	28.8	21.0	21.0
Number of test tries	39.8	38.7	35.9	33.4	26.3	27.9	33.7
Number of lesson tries	19.4	18.5	19.0	15.6	10.4	11.8	15.7

The most obvious difference as determined by comparison of data found in the table is the large increase in achievement gain between graduate students and freshman/sophomore level students. Notice that the gain in progressive from the freshman to the Ph.D. groups. This could be accounted for in several ways. One might be that the information covered in the freshman level class is not entirely new to all students and could have been obtained in high school study. Using this logic, it could be argued that the material in graduate course work is primarily new to most students and therefore any significant amount of previous knowledge would not be evident. Also, as indicated by the test scores, the tests were in the main objective multiple choice questions which might account for the rather high scores on the

pre-test to begin with. Any person with no previous experience in the subject might score 50 percent or better simply by being "test wise" and guessing at the answers.

In order to study further the variations in groups, it was possible to examine the data by course. All variables were processed by course and similarities or differences noted. The information in Table 43 compares the mean values by variables and courses participating in the study. The number system to designate the courses in 100 for freshman level and 600 for masters/doctoral level. Information provided by the student on each form identified the program level for each student. It was also possible for seniors to be in 100 level courses if they were transfer students or simply delayed taking the freshman class until their senior year. A cursory overview of course data did not identify any large number of upperclassman in a freshman level course which might alter the conclusions or implications of the interpretation.

Table 42

Mean Scores by Variable and Course

	ET 585	ET 626	PE 284	BIO 361	OCN 110	OCN 200
Pre-test scores	49.0	56.2	72.2	66.7	----	73.2
Post-test scores	80.2	89.6	80.1	89.1	92.8	92.6
Achievement gain	26.6	30.7	8.1	22.4	----	17.0
Average test tries	32.9	21.8	10.2	42.4	43.3	36.3
Average lesson tries	11.4	9.7	12.5	----	20.1	16.3

* Indicates did not take tests/lessons

Because of the variety of instructor preferences on how they wanted to use PHOENIX and the variety of course content involved in the study, some data in Table 42 was not available. For instance, OCN 110 did not require a pre-test so achievement gain was recorded as a matter of the first test and the last test taken, whenever it occurred. BIO 361 used only the test portion of PHOENIX and did not use any tutorial lessons to supplement classroom instruction as the tests were companion pieces to the workbook used in the class. Only ET 585 and ET 626 were controlled classes. Every student in each of these classes was required to take a pre-test prior to being registered on the CAI tutorial. In this way, it was possible to measure the actual achievement gain obtained from the CAI lesson and class lecture. As evidenced

by the data in Table 42, the greatest gain was obtained from the control classes as would be expected. By other classes using an open access to the PHOENIX system, students could take a lesson before they took a pre-test. By doing this the expected "pre-test" score would be significantly higher than requiring a test prior to any instruction. Also evidenced in Table 42 is the generally low scores for the ET 585 class, both pre and post test. This was account for in that the course dealt with digital/microprocessor electronics and virtually no students had any previous knowledge of the course content prior to their entry to it. The achievement gain for this course, however, was significantly higher than the gain obtained from the other "open" class structures.

The large number of students involved in the study and the near equal distribution of sex for the group allowed the evaluation of variables by sex. Table 43 lists the differences for the various variables compared to the male/female classification.

Table 44

Variable Mean Scores Classified by Sex

	Male	Female
Pre-test scores	63.3	63.4
Post-test scores	90.0	88.9
Achievement gain	21.9	19.9
Average test tries	35.3	32.0
Average lesson tries	9.8	14.2

As shown in the table, the mean values are not significantly different between male and female students until the average lesson tries. It appears the women take the lessons more times than their male counterparts. One way to account for this is to check the number of times an individual signed on the system and determine the length of time on the system. For example, if an individual only took half a lesson each time they signed onto the PHOENIX system, the record would show more tries for each lesson taken, although the student took the lesson only once. Although the difference is notable, it was unclear if the variation was large enough to warrant major notice. A closer check will be made in the future on this factor.

To examine the possibility that estimated grade point average had an effect on the pre-post test scores, achievement gain and time on task, a comparison was made between GPA and the previously used variables for the participants of the study. Table 45 identified the values for the computations in this comparison.

Table 45

Variables Compared to Grade Point Average

Variables Considered	GPA's 3.5-4.00	3.0-3.49	2.5-2.99	2.0-2.49	Below 2.0	Group Mean
Pre-test scores	57.1	65.5	58.9	64.3	----	63.3
Post-test scores	88.7	90.0	89.4	91.7	93.0	93.9
Achievement gain	26.7	18.2	16.2	23.5	----	25.2
Average lesson time	20.0	16.9	13.4	13.2	21.0	17.8
Average test time	6.8	6.2	6.8	5.4	7.3	6.3
Lesson tries	12.7	17.2	16.8	17.8	17.3	18.4
Test tries	28.3	34.8	35.3	42.6	38.5	42.6

As indicated by the table the mean scores by GPA and variable did not show any large difference in performance. It is interesting to note, however, that the students in the lower GPA classifications seemed to have the highest pre-post test scores and took the lessons more times than the brighter students. This would indicate that it took the low ability students longer and more tries to react to a level of achievement satisfactory for the course requirements. This is the beauty of the computer based education system. Provisions can be made for learning differences for various levels of students and not create hardships for others in the group. Also, although the low GPA students had higher pre-post test scores, the achievement gain was greater with the high GPA students. Note also that the high GPA students in the main spent more time on the system than the low GPA students. In assessing the data, it appeared that the high GPA student took the lesson fewer times but stayed on the systems longer once entered than the low GPA student. As indicated by the Test Tries, the low GPA students took almost twice as many tests as the high GPA students. Although the final post-test scores are not that different, it would appear that the low GPA student had to repeat the tests many more times to reach the level of the high GPA student test scores. It is not evident in this data table if the students took the pre-tests prior to the lessons or if the lessons were taken before any testing was done. In any event, the achievement level as indicated by the post-test scores for the high GPA students (88.7%) as compared to the scores for the low GPA students (91.7% for 2.0 - 2.24 students) does show that computer based education seems to be equally effective in overall achievement regardless of ability level. Low ability and high ability students both benefit from it although low ability students must spend more time to reach the necessary levels of excellence.

To determine if age was a factor in effecting the values of the variables in the study, a comparison was made between age groups and mean scores for each of the variables. Table 46 displays the values by variable and age grouping with the mean scores listed under each age grouping. Comparisons with the total group mean can be made by referring to Table 45.

Table 46

Variables Compared to Age Levels

Variables Considered	Mean Scores By Age Groups					Group
	18-21	22-29	30-39	40-49	50 above	Mean
Pre-test scores	70.5	65.8	52.2	54.1	65.5	63.3
Post-test scores	90.9	88.5	86.0	90.1	93.0	93.9
Achievement gain	14.5	20.3	27.9	31.0	26.0	25.2
Average lesson time	12.3	17.5	28.3	27.8	35.4	17.8
Average test time	5.8	6.7	6.9	7.5	7.2	6.3
Average lesson tries	18.4	13.8	11.3	12.0	13.9	18.4
Average test tries	38.5	27.7	28.4	29.3	29.3	42.6

By analyzing the findings of Table 46, there are several general observations that can be made about older students compared to the younger students 18 to 21 years of age category. For the most part older students tend to have more achievement gain, 14.5 for 18-21 year old students compared to 31.0 for 40-40 year old students. In addition, older students spend more time on both the instructional lessons and test programs than younger students. Although the younger students did better on the pre-tests as indicated by the mean scores the older students had a higher mean score on the post-test, although

the difference was only three percentage points. It appears that the older students take lessons and tests less often than younger students but spend longer times on both once entered. The net result is a greater achievement gain for the older students.

Information on mean scores was calculated by several other group classifications. For example, variable scores were computed in groups of "lesson tries" and "test tries" to see if any significant difference existed between the mean scores. It was shown that the more tries an individual student had for either the lesson or the test, the higher the post-test scores and the greater the achievement gain. This would be expected if the instructional program was valid and the test was representative of the instructional materials covered in the lessons. One interesting thing did occur in analyzing the data on "tries" was the large range of values identified. For example the group mean for "lesson tries" was 18.4. Several individuals took more than one shot at the lesson as their scores were 31. In comparing the tries against the courses enrolled, no significant relationships were identified by any specific class. That is, the tries were spread over the courses involved within the study and not bunched in one specific course. The mean score for the "test tries" was 42.5. A number of students took the tests several times with 75 students in the study taking at least 61 or more tries at the tests. This large range of scores for tries tends to raise the mean value. Also, it should be noted that if both pre and post tests were required, all students would take two tests per lesson. If a course had 10 lessons, the minimum number of test tries would be 20. As many students took the post-test several times, this value would be somewhat determined by the

course requirements and the number of lessons in each course. In analyzing the data by tries, no significant findings were evident other than the more tries, the higher the post-test scores and the greater the achievement gains as would be expected.

The total population involved in the study crosses several discipline categories and grade levels. Some faculty used the PHOENIX system as a support system, some required lessons or tests, others made the use of the system optional. In order to more tightly control the conditions and circumstances under which information was collected, two courses were used as a control group with close monitoring and specific course requirements made on the PHOENIX system. These two classes were ET 585, Digital Microprocessor Electronics and ET 626, Computer Based Education. The two classes were taught by the same instructor and maintained the same testing/instructional requirements. The total number of students in this "controlled group" was 135. The data of this control group was treated as part of the total population in the first part of this study. To see if any significant differences existed within a group which had tight controls and CBE interaction requirements, a separate data set was made from the total population and the analysis for this category follows.

In analyzing the data, it was obvious that the age differential of this group would be very different. There was only one individual in the 18-21 year old age bracket of the 134 participants. This means that the data obtained was from an older more mature population and characterized primarily graduate students. Almost without exception the older age groups participating in the study come from these two classes. One hundred thirty-one of

the 135 students were in the Masters or Doctoral program. The four undergraduate students in these courses were last quarter seniors who can enroll in graduate classes with special permission of the instructor and the graduate school.

In analyzing the date for the "control group", an overview of mean scores and values did not differ significantly from the total population of the study as far as attitudes were concerned. The responses relating to the attitudes towards the PHOENIX system and the instructional software within it are not greatly different from the responses from the total population. A few percentage points in the various items were thought to be similar to the judgments of the total group so no separate tables were created.

An attempt was made to run some CHI Square computations on the control group similar to the total population. In several instances, the numbers in the control group were not sufficient to match the table frequency distributions with adequate numbers so reliable and valid judgments could be made. There were several indications, however, that the control group did differ from the total population in several instances.

The correlation between "test tries" and post-test scores was higher for the control group. Every student in the control group was required to take a pre-test prior to being registered in the instructional program. This requirement lowered the pre-test scores for the control group by a significant value. A value of 53.8% for the control group vs. 63.3% for the total population. The testing of students prior to instruction can establish a baseline value from which new learning can be measured. By not requiring a pre-test prior to instruction, some learning can take place which would not be

evident in a pre-post test arrangement by comparison. In requiring a pre-test prior to instruction, a greater achievement gain was recorded by the control group. This value was 29.3 for the control group vs. 25.1 for the total population.

Another assessment made with the control group which appeared to be significant when compared to the total population was the linear relationship between the number of tries on instructional lesson and the scores on the post-test. With the control group, a greater gain was made by these students. There was some concern statistically that the number of students in the table was of some concern, as some of the cells had insufficient numbers to provide valid data for a CHI Square computation. The relationship was just barely significant at the .052 level of confidence.

Related to the tries vs. post-test scores was the relationship of time on the system to achievement gain. With the control group tightly monitored, it was possible to make a valid assessment of the time spent in instruction vs. the achievement gain for students on the system. In computing the CHI Square for these two factors, the relationship was significant at the .029 level of confidence. The more time spent on the system by students, the higher their post-test scores and the greater their achievement gain. There was a point reached at which the time failed to produce and great gain in the post-test score. This point was reached when the students spent twice the time on a lesson as the estimated time anticipated by the author. For instance, if a lesson was written to be completed in 30 minutes, spending more than a hour on it failed to produce any greater pain in post-test score. No attempt was made to see if separation of time, that is, 30 minutes one day and another 30

minutes the next day or next week, would create a greater post-test score. Time on task was accumulative and no indication of the spread, if any, in the total time spent on the system was made.

Table 47 below provides the variable mean scores for the control group and a listing of the mean scores for the total population. Keep in mind that the total population did include the control group and involved 400 students. The control group, on the other hand, included only 135 of these students, who were primarily at the upper end of the age bracket for the total population.

Table 47

Mean Values for Variables of the Control Group

Variables Considered	Mean Scores Control Group	Total Population
Pre-test scores	53.8	63.3
Post-test scores	87.1	93.9
Achievement gain	29.3	25.2
Average lesson time	22.3	17.6
Average test time	7.9	6.3
Average lesson tries	10.3	18.4
Average test tries	25.7	42.6

As indicated in the table, the controlled group spent more time on the system, had a larger achievement gain and took fewer tries to complete a lesson and/or test.

Chapter 5

Summary, Conclusions, Implications and Recommendations

Introduction

Computer based education is a relatively new mode of delivery for public education. Several experimental systems have been in operation for a little over 20 years and most were large mainframe applications in the elementary school. It was not until recently that the microcomputer became a viable system of instruction for both elementary and higher education. Although the microsystem is now economically within reason, it is the large mainframe system that is providing the management and tutorial delivery for large applications. This study looked at the testing and instructional tutorial delivery system called PHOENIX created by Goal Systems Incorporated of Columbus, Ohio. The installation was utilized by the University of Northern Colorado in several types of courses during the school year and summer program of 1984-85.

A synthesis of research undertaken by Kulik, et. al. in 1984 and supplemental evaluations since then have determined the following general conditions about computer based education.

1. CBI can improve student learning and can generally raise test scores from the 50th to the 63rd percentile.

2. Student attitudes toward the subject being learned and student ratings of the quality of instruction are slightly more favorable with CBI.

3. In contrast to traditional instruction, student attitudes toward computers are strikingly more positive as a result of experiencing CAI.

4. CBI has been reported to save anywhere from 39 percent to 88 percent of student learning time.

5. Because of the rapid change in computer technology and classroom use of computers, these findings do not necessarily predict future results.

In order to make a general assessment of these findings in a university setting with a mainframe computer, this study was undertaken to validate the previous research and supplement it with new information. For example, little was known about the applications of computer across subject disciplines. To this end, course applications in several types of classes were selected. Also, as indicated by Kulik in his meta-analysis, most of the data was obtained from microcomputer applications in elementary and high school applications. Very little has been done in the adult and higher education applications with the exception of the military technical training programs. Likewise, not much information was available for laboratory type course applications.

The Purpose of the Study

The purpose of this study was to evaluate college student attitudes toward computer based education and to gage the instructional effectiveness of CAI achievement and testing in a variety of disciplines in a university setting. Questions concerning attitudes toward the operation of the computer terminals, ease of system use, effectiveness of the instructional system toward retention of course material, pre-post test achievement scores and achievement gains, value of time spent on the system, and preference of students in examination delivery were included. In addition, to help in the future planning for new applications, it was helpful to know how much time each student spent on each mode of instruction with an open access system. If

new classes were to be added to the system, information on terminal availability, average student use time, response time and similar questions had to be answered.

For the purpose of this study, Computer Based Education (CBE) was used as a broad generic term which included all applications of the computer for instruction and testing. Computer Assisted Instruction (CAI) was interpreted to mean instructional tutorial delivery where information was transmitted to the student in a one to one setting. Computer Managed Instruction (CMI) was interpreted to mean the deliver of tests and scoring of the student progress as new lessons and tests were taken. Most classes were involved with the dual application of the PHOENIX system as a total system of computer delivery.

Methods and Procedures

The population of the study consisted of 400 students enrolled in five university courses. These courses included Microbiology, Oceanography, Computer Based Education, Physical Education and Digital/Microprocessor Applications. Two of the courses had extensive laboratory work involved in it so comparisons could be made between general lecture type classes and laboratory classes. Also, the population included freshman level course work and graduate classes. No experimental or control groups were used in the initial study as the data needed for beginning implementation of PHOENIX at the University of Northern Colorado was preliminary and planning in nature. The study was a descriptive evaluation of a trial system in a university setting. Fifty-two percent of the population was male and 48 percent was female. Fifty-three percent of the population were between the ages of 18 and 21, 47 percent were between the ages of 22 to 50. The mean age of the total popula-

tion was 23.2 years. Sixty-three percent of the population had a grade point average (GPA)(of 3.0 or higher. The graduate student population raised this from the norm as they were a select group different from the normal population in the undergraduate setting.

Findings, Conclusions, Implications and Recommendations

The following information is presented in light of the questions raised in the original purpose of the study. Data will be cited which answers the question posed and interpretations will be made based on relevant information obtained from the responses of the student involved.

Question:

How much time does a student spend on the PHOENIX Computer Based Education System for a given class and in which modes of operation?

The two modes of computer based education address were the testing and instruction mode. The majority of students (54.1%) estimated they spent about 5 minutes on testing. In reality, by collecting the actual time spent in testing, the average student spent 9.86 minutes per test, almost double their estimate. Likewise, 79% of the students estimated they spent less than 30 minutes per lesson on the tutorial. Their judgment was a little more accurate in this case as the computer calculated they actually spent 24.9 minutes in the tutorial mode. In reality, the longer one spends on the system the more accurate their judgment is likely to be. An implication which could be drawn from the results of this data is that one might believe that time spent on the system is not a drag on the students and that it passes much faster than they realize, especially in the testing mode.

The average student had 27 testing sessions for a total time of 4 hours and 44 minutes within a 10 week time period. The average number of instructional sessions were 18.4 with a total time of 4 hours and 15 minutes in the tutorial mode. It is interesting to note that although the students spent less than half the time in a test than they did for a lesson, the total time testing exceeded that of instruction. This is accounted for in that students could take the tests in most courses as many times as they wanted to in order to raise their final test score. The average number of test tries were nearly double that for lesson tries. In totals, to determine the number of terminals, student access time to the system etc., it is estimated that supervisors should plan at least 9 to 10 hours contact with the system for each student registered on it. To increase student/teacher utilization of the PHOENIX system at UNC, usage, terminal purchase, student monitoring and faculty applications can be more closely estimated in the future.

Question:

What attitudes are held by students toward CBE who have had experience on the PHOENIX mainframe system?

Students were asked to respond to both the CAI and CMI applications of the PHOENIX system. Only those who actually used each of the modes were provided input. Over seventy-eight percent of the 400 student involved in the study indicated that they felt the PHOENIX testing or CMI mode was very worthwhile. Only 3.8 percent of those who experienced the testing mode felt it was fair or a waste of time. The responses indicate that most feel computer tests can contribute much to their learning experience and favor its use.

The CAI or instructional application of PHOENIX was also favorably evaluated. Ninety-four percent of the 400 students rating the CAI system said

it was good, very worthwhile or outstanding. The majority, 49.5 percent rated CAI as a very worthwhile experience from their point of view. In comparing the two modes of operation, slightly more students rated the testing applications more useful than instruction. The difference was not great but noteworthy. This finding would imply that to begin implementation of PHOENIX, the initial contract for both students and teachers would be to enter some form of testing on the system. Instruction could be added at a later time and fuller utilization could be made if this sequence was followed. Based on discussions with the faculty of the courses involved in this study, they tended to agree that the easiest mode of entry for the CBE system was the test mode. They indicated that additional learning time was required on their part to develop sound educational tutorials which would follow some prescribed model. As an entry level experience, time was not provided by the university to initiate effective CBE in the tutorial mode.

Question:

Are the attitudes of students different in free vs. a controlled environment regarding the PHOENIX system?

Provision was made within the study to establish an optional and required structure regarding the PHOENIX usage. The Computer Based Education classes and the Digital/Micro-processor classes were required to take lessons and tests on the computer and were told that part of their final grade would be calculated from this exposure. The other classes were given an option of participating on PHOENIX in either the CAI or CMI mode. In comparing the data from both groups, it was found that the evaluations for both the CAI and CMI modes were the same for both groups. The requirement did not alter the attitudes of the students toward the system when compared to the optional

structure. It is interesting to note also, that without exception, all of the students who were given an option to use PHOENIX did so to some extent. It was assumed that their curiosity provided enough motivation to at least make each student sign on to a test or lesson at least once to see what it was like. In analyzing the data, the minimum number of tries on PHOENIX for any student was 2 with the maximum being 227. One student took each test an average of 16 times. It should be noted that the test file had more test items than were given to any student at one entry. By entering several times, the system provided a new and random list of questions for each try. In this way, students would need to make many passes to see every test item in the file. From the evidence gathered on the number of tries for testing, it is concluded that the majority of students did in fact use the multiple entry on the test mode to study for the midterm and final exams.

Question:

Are students who use Computer Based Education fearful of terminal operation and the system in general?

Several questions were asked in the study to answer this question. In a direct response to students about apprehensiveness of terminal operation, 55.5 percent said they experienced such fear. Thirty-five percent said that there was some fear at first but that it did not last long once acquainted with the system. In making some implications regarding CBE, it is evident that some time should be spent early in the course to orient students to terminal operation and to make them feel at home with it. Experience dictates that it will take at least 30 minutes or more of terminal operation supervision for most students to overcome this fear. Within this orientation period, students should be given instruction on getting on and off the system, properly

entering data from the keyboard, what to do if data is not accepted by the terminal or system and what to do if the system goes down. The operation of a non-supervised terminal in the early part of a CBE experience tends to make students more apprehensive toward the system in general.

Related to this question of apprehensiveness was one of ease of terminal operation. As would be expected, 47 percent of the students in the study indicated that terminal operation was not easy. This assessment goes hand in hand with their fear of the system. Although the majority of the students had a fear of the system and said the terminals were hard to operate at first, it did not change their attitude toward the benefits of the system to their learning experience. In utilizing CBE in classroom settings, great care should be taken to get students off to a good start with the hardware of the system and time should be spent with the students in the proper use and care of the terminal.

Question:

How does terminal availability affect CBE operation and course/student assignment?

Because of the newness of the PHOENIX system at UNC and the lack of information available on how many terminals are required per student for maximum utilization of the system, students were asked to respond to this item. It was hoped that some sort of judgment could be made to help determine the number of students per terminal needed to satisfactorily administer the system. Based on student response, 64.5 percent of the students did experience some sort of problem in obtaining access to the system or terminal when they wanted it. For this study, 13 terminals were available in three locations in an unsupervised setting. Four terminals were housed in the library

and were accessible during library hours. Three terminals were in the computer center and available 24 hours a day and 6 terminals were in the Educational technology center, open from 8:00 a.m. until 5:00 p.m. daily with arranged times provided in the center for 7:00 to 10:00 p.m. operation. Over 600 persons were registered on the system. Data obtained for this study were accumulated from students who had access to the terminals under these conditions. A total of 13 terminals were available for 600 student registrations during the study time period. Based on experience, it is again recommended that a ratio of no more than 20 students to one terminal be established for maximum CBE effectiveness. This will allow each student to have access to the terminal at least two hours per week for testing and instruction. Also, supervised operation should be available for some terminals to expedite monitored testing of students in a controlled environment.

Question:

What are the implications for the response rate from the computer to the students attitude toward the CBE system?

Related to terminal availability and attitude toward the system was the response time of the system. Students who experience CAI or CMI do not like to wait for extended periods of time for the computer to answer their input. Because PHOENIX was allocated one partition from the university computer, other university operations at certain times had a tendency to slow down the operation of the response to the PHOENIX terminals. Students were asked to rate the delay in time as a factor toward their instruction on the system. Eighty-one percent did indicate that the delay in response had a negative effect on their attitude toward the system and said that it was a problem. Some related that after several sessions at different times, it was fairly

easy to determine the best times to take lessons or tests and did so when the response time was better. A delay of over 2-3 seconds was judged by the students as excessive and tended to bother their concentration on the materials of the lesson. Since this study was completed, a new computer system was installed at the university which generally doubles the speed of operation of the system and has reduced the response time of the PHOENIX terminals by half. Response time is no longer a problem with the system as it is now configured at UNC.

Question:

What elements of screen design influence the interaction of students who utilize CBE?

About 92 percent of the students in the study indicated that the screens presented to them were easy to read and interesting. This supports the guidelines used for screen design for the system now in use. Small modifications or variations were made as new lessons or materials were entered by the guidelines followed in creating the tests and lessons were satisfactory. In general, screens were kept to a 40 character width and a maximum 20 line length with 2-3 paragraphs of information for the scripts and one item per test question. In certain circumstances, authors were given freedom to meet their own needs. Each screen was kept to a single concept presentation if possible and progressive levels of difficulty were established if complex ideas were to be learned. Where possible, existing theories of learning were incorporated in the development of the lessons to improve the educational effectiveness of the system.

Question:

What physiological factors such as eye fatigue effect the operation of a CBE system from the students point of view?

As indicated by the respondents, eye strain or fatigue did not appear to be a major problem for students in the study. Over 27 percent of the students did experience some problems with the visual display. Most of these problems were the result of prolonged exposure to the screen. The time limit suggested by the students was about 45 minutes per session. If a longer time was experienced, the students in general indicated that their eyes began to bother them. It is therefore suggested that as a result of this study, no lesson be created that will take longer than 30-45 minutes to complete and that students be told that they should not stay on the system for a period longer than 45 minutes. In PHOENIX, it is possible to lock out students after a period of time and determine the length of time they will be locked out of the system. If student options are not effective in monitoring this factor, then the system should be structured to control it.

Question:

Should the use of the PHOENIX for supplemental instruction be required or optional at student request?

Sixty-three percent of the students in the study indicated that the use of PHOENIX should be a required part of the course in which they were enrolled. Only 20 percent said it should be optional at the students request. The rest of the respondents, 17 percent, had no opinion or stipulated that it was a good experience but didn't contribute much to their progress. Only 4 percent of this group found that PHOENIX did not help them much in learning the class material. In closer examination of this group, most were off campus students who did not have ready access to the PHOENIX system as they commuted to class from out of town or did not live close to campus and access to the system. Based on this observation, teachers who use

PHOENIX as a part of their instructional program should strongly recommend it to their students although to make it a class requirement may put undue hardship on off-campus students.

Question:

How would you rate CBE for initial contact learning of new information and course concepts?

In general, most students would rate the use of PHOENIX as a contributing factor to their initial contact in a course. Eighty-six percent said the system was very beneficial and judged it more useful for obtaining new information than traditional textbooks. The rest said it was no more beneficial than traditional modes of presentation or in six cases, rated it as less useful than traditional text/materials. Based on this response, PHOENIX can be used as a significant instructional element in presenting instruction to students in most all courses. In analyzing the attitude toward the system by class as well as assessing the total populations response, there was no significant difference between disciplines in their attitude toward obtaining new information. Likewise, in breaking the responses down by sex, both men and women felt that it was a useful tool and recommended that most all student use it in their learning experience.

Related to the usefulness of PHOENIX for learning new information was the comparisons of attitude toward the system when compared to learning ability. It was thought that high aptitude students might feel differently toward CAI than low aptitude students. Although 75 percent of the students in the study created their learning ability above average, the attitudes of the two groups did not show a significant difference. Low ability students gain as much from CAI as high ability students. The net achievement gain by both groups was

approximately the same although high ability students did have a slightly higher point gain. Age was a greater factor in determining achievement using PHOENIX than sex or ability level. The most significant element in learning new information on the PHOENIX system was the time spent on the system. Without exception, those students who spent more time on the CAI portion of the system did significantly better on post-test scores than those who spent less time on it.

Question:

What factors control average time spent on the system by students for CAI and testing in a normal university course?

With the utilization of PHOENIX, records are maintained within the system for time spent, tries or sessions held and pre-post test gain scores within the materials. The following data represent mean scores for the lessons and test materials for the total population of the study. When analyzed by course, sex and ability level, the values of the subgroups identified above did not differ significantly from the mean values listed below. Only age began to make the differences a bit more significant. In an analysis of variance, none however, were determined to be significant at the .05 level of confidence.

Actual time spent on each lesson	29.15 minutes
Actual time spent on each test	15.05 minutes
Estimated lesson time by student	17.76 minutes
Estimated test time by student	6.29 minutes
Total LESSON time spent on each course	6 hrs. 6 minutes
Total TEST time spent on each course	4 hrs. 31 minutes
Total CBE time for each student per course	9 hrs. 44 minutes
Average number of CAI sessions per student	18.4 entries
Average number of Test sessions per student	42.5 entries
Average total number of entries per student	59.4 entries

Average age of the students in the study	22.2 years
Youngest age of student in the study	18
Oldest age of student in the study	50
Average course grade for students in class	3.30 (B+)
Average estimated GPA of students in study	3.17 (B)
Average GPA gain for CBE students in study	.13 GPA
Average pre-test score for total group	63.3%
Average post-test score for total group	93.8%
Average achievement gain per student/course	25.1%
Average pre-test for experimental group	53.28%
Average post-test for experimental group	87.59%
Average achievement gain for exper. group	34.31%

The conclusions drawn from the information in this study support the research previously done on CAI and reported by KULIK and others (Kulik, 1983) in their meta analysis on micro systems hold true for large mainframe systems as well. In addition, the research completed by the U.S. Army Signal Center at Ft. Monmouth, New Jersey in 1972 which concluded that CAI was a feasible method of instruction was upheld.

If CAI and CMI are to be incorporated into the university of higher education programs, adhering to the following guidelines should be helpful in planning and implementing a computer based education system. These recommendations are made from the findings of this research and from an analysis of data obtained in previous research.

RECOMMENDATIONS:

1. CAI can be implemented to teach the information component of most any subject. In creating the instructional materials, some format or instructional design system should be followed to increase the efficiency and effectiveness of the system.

2. Tutorial lessons should be designed in segments of no more than 30-45 minutes per session. Eye strain and other physiological factors reduce the learning capabilities of students if this time is extended.

3. Test items should be integrated with the instructional lessons so linking or "interactivity" between testing and instruction can be facilitated by objective. It is also possible to evaluate the student achievement in levels of performance if this structure is followed.

4. Students generally spend twice the time on an instructional lesson than the time planned by instructors. The average student will take each lesson twice and teach test 4 times to reach the grade level anticipated by the teacher. The contact time per terminal for each student should take this into consideration.

5. Computer Assisted Instruction should be used as a supplemental mode of instruction and not as a replacement for teachers. Students still feel a need or personal contact with the teacher and find some things can be taught more efficiently by demonstration and discussion. The computer does work very well for initial contact learning of facts and information which is required for higher level skill development.

6. Not all students can benefit from CAI equally well. Those with physical problems or reading difficulties will need some alternative mode of presentation. Students with relatively low and high learning abilities do benefit from CAI. The net gain or achievement for each group is about the same.

7. In comparing terminal availability and students on the system, it is suggested that no more than 20-25 students can be placed on one terminal if instruction is designed for a one hour lesson per week. This will generate about 2 hours per week of computer of access time per student for teaching and testing. The availability of terminals and response of the system, make this contact reasonable.

8. For testing with a mainframe CBI system like PHOENIX, some arrangements need to be made for monitoring exams and controlling student access to the evaluation portion of the system. Large group testing which is valid and reliable can be achieved in this way with less instructor time required to administer and score the tests.

9. Achievement gains for students in lab type courses vs. general education lecture courses are not significantly different. It is therefore recommended that CBE can be utilized in virtually all course disciplines, at least for initial contact learning which address the terminology of the field and comprehension level cognitive skills.

10. Students using CBE preferred to choose the use of CBE rather than having it required of then, most suggested that they retained of them, most suggested that they retained the material better by using CBE when compared to traditional classroom lecture. It is therefore

recommended that students use CBE as supplemental instruction to retain information but receive traditional contact with teachers on a regular planned basis.

11. It is recommended that CBE be utilized as an optional testing system for those students who wish evaluations on demand and that provision be made to monitor those examinations to guarantee security and validity of the test. Further, that those students who wish traditional test be given that option.

12. Student progress and achievement on the CBE system seemed universal across variables of sex, aptitude, GPA, and Learning Ability. A significant difference did exist with the factor of age. It is recommended that serious consideration be given to using CBE for inservice programs adult education (25 years and up) as mature students appear to get better achievement gains with CBE than younger students.

APPENDIX A

SAMPLE RESPONSE SHEET

PHOENIX EVALUATION

PLEASE USE A NUMBER 2 PENCIL.
COMPLETELY MARK THROUGH THE = THAT
CORRESPONDS TO YOUR RESPONSE.

DO NOT 0 = 0 1 2 3 4 5 6 7 8 9
WRITE 0 = 0 1 2 3 4 5 6 7 8 9
IN THIS 1 0 = 0 1 2 3 4 5 6 7 8 9
SPACE 1 0 = 0 1 2 3 4 5 6 7 8 9

INTRODUCTION: THE FOLLOWING INFORMATION IS NEEDED TO HELP EVALUATE THE USE OF PHOENIX AND THE USE OF COMPUTER BASED EDUCATION IN GENERAL. PLEASE FILL OUT THE FORM COMPLETELY, ANSWERING HONESTLY. YOUR RESPONSE WILL IN NO WAY EFFECT YOUR FINAL CLASS GRADE OR COURSE EVALUATION. ADD BRIEF EXPLANATIONS TO YOUR ANSWERS IF NECESSARY.

UNC STUDENT NUMBER:_____NAME_____

QUARTER ON PHOENIX: FALL = WINTER = SPRING = SUMMER =

AGE:_____

SEX: MALE = FEMALE =

CLASS: FR. = SOPH. = JR. = SR. = M.A. = PH.D. =

MAJOR AREA OF STUDY:_____

WHAT IS YOUR ESTIMATED GRADE POINT AVERAGE? = 2.5 - 4.0 = 3.5 - 4.0
= 2.5 - 2.999 = 2.0 - 2.499 = BELOW 2.0

WHAT CBE PROGRAM(S) DID YOU TAKE? CAI = _____ (TUTORIAL)
CMI = _____ (TEST)

WHAT IS YOUR BEST JUDGMENT REGARDING THE VALUE OF THE PHOENIX SYSTEM AND ITS PROGRAMS FOR LEARNING AND/OR TESTING?

CMI	CAI
= OUTSTANDING	= OUTSTANDING
= VERY WORTHWHILE	= VERY WORTHWHILE
= GOOD	= GOOD
= FAIR	= FAIR
= WASTE OF TIME	= WASTE OF TIME

WHAT IS YOUR FEELING ABOUT TERMINAL OPERATION FOR PHOENIX?
= VERY EASY
= EASY
= DIFFICULT AT FIRST BUT NOW EASY
= VERY DIFFICULT

ARE YOU APPREHENSIVE ABOUT TERMINAL OPERATION AND USING PHOENIX.
= VERY MUCH
= AT FIRST BUT NOT NOW
= NO BIG DEAL, NO MAJOR PROBLEM
= NOT AT ALL

HOW MUCH TIME DID IT TAKE FOR YOU TO COMPLETE THE AVERAGE LESSON?
CAI (TUTORIAL) MINUTES_____ CMI (TEST) MINUTES_____

WAS THE SCREEN DISPLAY AND FORMAT EASY TO READ AND INTERPRET?
= YES
= NO EXPLAIN_____

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PAGE 2

PHOENIX EVALUATION

PLEASE USE A NUMBER 2 PENCIL.
COMPLETELY MARK THROUGH THE = THAT
CORRESPONDS TO YOUR RESPONSE.

DO NOT WRITE IN THIS SPACE

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0 = 0 0 0 0 0 0 0 0 0
1 0 = 0 0 0 0 0 0 0 0 0
2 0 = 0 0

13. IF YOU USED DIAGRAM BOOKS, WERE THEY ADEQUATE AND HANDY FOR YOU TO USE?
= YES
= NO EXPLAIN_____
= DID NOT USE

14. WERE THE SCREEN/PROGRAM DIRECTIONS CLEAR FOR THE LESSON/TEST?
= YES
= NO

15. WERE THE OBJECTIVES FOR THE LESSONS AND TEST CLEAR?
= YES
= NO

16. DID THE COURSE AND UNIT DESCRIPTIONS GIVE YOU ENOUGH INFORMATION TO WHAT THE COURSE OR THE LESSON/TEST COVERED?
= YES
= NO

17. WAS THE INFORMATION IN THE TUTORIAL AND THE NUMBER OF RESPONSE ITEMS ADEQUATE TO HOLD YOUR INTEREST IN THE LESSON?
= YES
= NO

18. WERE THE TERMINALS AVAILABLE WHEN YOU WANTED TO TAKE A LESSON/TEST?
= YES
= MOST OF THE TIME--HAD SOME PROBLEM
= NO--DIFFICULT TO GET ON THE SYSTEM.

19. HOW WOULD YOU RATE THE WORTH OF THE COMPUTER LESSONS/TEST IN ACHIEVING THE OBJECTIVES AND INFORMATION IN THE COURSE.
= VERY BENEFICIAL
= CONTRIBUTED SOME
= NO BETTER THAN TEXT BOOK
= DID NOT HELP MUCH IF AT ALL

20. DID THE COMPUTER LESSONS HELP YOU REMEMBER THE MATERIAL TAUGHT IN THE COURSE BETTER THAN A TEXT OR TRADITIONAL LECTURE PRESENTATION?
= YES - CAI BETTER
= NO - TEST/LECTURE BETTER
= NO MAJOR DIFFERENCE

21. DID YOUR EYES BOTHER YOU AS YOU TOOK A LESSON OR TEST? (IS VIEWING THE SCREEN A PROBLEM?)
= YES
= NO

22. WAS THE RESPONSE RATE FROM THE COMPUTER A PROBLEM IN MOVING THROUGH A LESSON OR ANSWERING TEST QUESTIONS?
= YES
= AT TIMES VERY SLOW (5 - 10 SECONDS)
= NO MAJOR PROBLEM

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PAGE 3

PHOENIX EVALUATION

PLEASE USE A NUMBER 2 PENCIL.
COMPLETELY MARK THROUGH THE = THAT
CORRESPONDS TO YOUR RESPONSE.

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1 0 ➡ 0 0 0 0 0 0 0 0
3 0 0 ● 0

1. HOW WOULD YOU RATE THE QUALITY OF THE TUTORIAL LESSONS OR TEST ITEMS?
   = VERY GOOD
   = ABOVE AVERAGE
   = AVERAGE
   = POOR

2. WAS THE READABILITY OF THE MATERIAL SUITABLE (DIFFICULTY-TERMINOLOGY-ETC.)?
   = YES
   = NO EXPLAIN_____

3. DID THE PHOENIX LESSONS/TESTS HELP YOU LEARN MORE THAN TRADITIONAL INSTRUCTION?
   = YES - PHOENIX RAISED MY LEARNING
   = ABOUT THE SAME
   = NO - PHOENIX HELD ME BACK

4. DO YOU FEEL THAT PHOENIX HELPED YOU ENOUGH THAT IT SHOULD BE MAINTAINED AS A VALID INSTRUCTIONAL TOOL?
   = YES - KEEP AND USE
   = NO OPINION
   = NO - DROP AND GO BACK TO TRADITIONAL INSTRUCTION AND TESTING

5. DID YOU LIKE TO TAKE LESSONS/TESTS ON THE COMPUTER?
   = YES
   = NO EXPLAIN:_____

6. FOR FINAL EXAMS WOULD YOU PREFER TRADITIONAL TEACHER ADMINISTERED EXAMS AT THE END OF THE QUARTER OR MONITORED COMPUTER ADMINISTERED EXAMS WHEN YOU ARE READY TO TAKE THEM?
   = TEACHER TESTS AT END OF THE QUARTER
   = COMPUTER TESTS ON STUDENT DEMAND
   = NO OPINION--EITHER OK

7. DID USING THE COMPUTER FOR INSTRUCTION MAKE YOU FEEL YOU WERE WASTING TIME?
   = YES
   = NO

8. DID YOU FEEL THE LESSONS WERE "PERSONALIZED" ENOUGH FOR YOU?
   = YES
   = NO
   = NO OPINION

9. DID YOU AT ANY TIME FEEL THREATENED BY THE COMPUTER AS YOU WERE TAKING A LESSON OR TEST?
   = YES
   = NO

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PHOENIX EVALUATION

ASE USE A NUMBER 2 PENCIL.
PLETELY MARK THROUGH THE = THAT
RESPONDS TO YOUR RESPONSE.

DO NOT WRITE IN THIS SPACE

0 1 2 3 4 5 6 7 8 9

. SHOULD THE USE OF PHOENIX FOR SUPPLEMENTAL INSTRUCTION BE REQUIRED FOR CLASS INSTRUCTION OR SHOULD IT BE MADE OPTIONAL AT STUDENT REQUEST?
= REQUIRED - GOOD HELP
= GOOD EXPERIENCE BUT NOT MUCH HELP TO LEARNING
= OPTIONAL - PREFERRED TO LEARN SOME OTHER WAY
= NO OPINION - COULD LIVE WITH IT EITHER WAY

IN GENERAL, HOW WOULD YOU RATE THE USE OF COMPUTERS (PHOENIX) FOR LEARNING NEW INFORMATION?
= VERY BENEFICIAL
= NO BETTER THAN TRADITIONAL SYSTEMS
= NOT AS GOOD AS TRADITIONAL TEXTS OR READING MATERIALS

.. HOW WOULD YOU CLASSIFY YOUR LEARNING ABILITY?
= VERY HIGH
= ABOVE AVERAGE
= AVERAGE
= MUST WORK VERY HARD TO LEARN

. DID YOU SPEND MORE TIME STUDYING WHEN YOU USED PHOENIX THAN IN OTHER CLASSES WITH TRADITIONAL INSTRUCTION?
= MORE TIME WITH PHOENIX
= ABOUT THE SAME
= LESS TIME WITH PHOENIX

. BRIEFLY STATE YOUR GENERAL REACTION TO COMPUTER BASED EDUCATION AS YOU HAVE EXPERIENCED IT ON PHOENIX.

POSITIVE:

NEGATIVE:

THANK YOU — RETURN THE FORM TO THE INSTRUCTOR.

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APPENDIX B

RAW DATA

PHOENIX RESEARCH -- UNC 1985

D. L. Jelden

Educational Technology Center

DEMOGRAPHIC INFORMATION ABOUT THE STUDY

	Number
Total students in the study	602
Number with full data available	400

SEX OF STUDENTS COMPLETING INFORMATION FORMS

	Number	Percent
Males	207	53.0%
Females	188	47.6%
Unknown	5	- -
	---	-----
	400	100.0%

AGE OF STUDENT COMPLETION INFORMATION FORMS

Age Range	Number	Percent
18 - 21	212	53.0%
22 - 29	82	20.5%
30 - 39	69	17.3%
40 - 49	25	6.3%
50 over	12	3.0%
	---	-----
	400	100.0%

ACADEMIC RANK

Class	Number	Percent
Freshman	85	21.6%
Sophomore	80	20.3%
Junior	43	10.9%
Senior	51	12.9%
Masters	108	27.4%
Doctoral	27	6.9%
Unknown	6	- -
	---	-----
	400	100.0%

COURSES TAKEN BY STUDENT POPULATION OF THE STUDY

Course	Number	Percent
Oceanography	176	44.5%
Computer Based Education	100	25.3%
Physical Education (Tennis)	53	13.4%
Digital Electronics (lab)	42	10.6%
Microbiology	24	6.1%
Unknown	5	- -
	---	------
Total	400	100.0%

ESTIMATED GRADE POINT AVERAGE OF STUDENT POPULATION

Range	Number	Percent
3.5 - 4.0	135	34.9%
3.0 - 3.49	113	29.2%
2.5 - 2.99	83	21.4%
2.0 - 2.49	48	12.4%
1.99 below	8	2.1%
Unknown	13	- -
	---	-----
	400	100.0%

AVERAGE TEST TIME SPENT ON THE COMPUTER BY STUDENTS

Minutes	Number	Percent
0 - 5	204	54.1%
6 - 10	120	31.8%
11 over	56	14.1%
Unknown	23	- -
	---	-----
	400	100.0%

AVERAGE LESSON TIME SPENT ON THE COMPUTER BY STUDENTS

Minutes	Number	Percent
0 - 14	177	44.3%
15 - 29	141	35.1%
30 - 49	55	13.8%
50 over	27	6.8%
	---	-----
	400	100.0%

TOTAL NUMBER OF STUDENTS IN CMI/CAI

Application	Number
CAI	322
CMI	342
Unknown	136

STUDENT RESPONSES REGARDING THE PHOENIX CBE SYSTEM

1. What is your best judgment regarding the value of the PHOENIX system and its programs for learning and/or testing?

Response	CMI Number	Percent
Outstanding	98	24.5%
Very Worthwhile	216	54.0%
Good	71	17.8%
Fair	10	2.5%
Waste of Time	5	1.3%
	---	-----
	400	100.0%

CAI

Response	Number	Percent
Outstanding	92	24.6%
Very Worthwhile	185	49.5%
Good	76	20.3%
Fair	19	5.1%
Waste of Time	2	.5%
Unknown	26	- -
	---	-----
	400	100.0%

2. Are you apprehensive about terminal operation and using PHOENIX?

Response	Number	Percent
Very much	222	55.5%
At first - not now	142	35.5%
No major problem	34	8.5%
Not at all	2	.5%
	---	-----
	400	100.0%

3. What is your feeling about terminal operation for PHOENIX?

Response	Number	Percent
Very Easy	29	7.3%
Easy	93	23.3%
Difficult at first	90	22.5%
Very Difficult	188	47.0%
	---	-----
	400	100.0%

4. Was the screen display and format easy to read and interesting?

Response	Number	Percent
Yes	367	91.8%
No	33	8.3%
	----	-----
	400	100.0%

5. If you used diagram books, were they adequate and handy for you to use?

Response	Number	Percent
Yes	114	28.3%
No	20	5.0%
Did not use	266	66.7%
	----	-----
	400	100.0%

6. Were the screen/program directions clear for the lesson and/or the tests?

Response	Number	Percent
Yes	389	98.0%
No	8	2.0%
Unknown	3	- -
	400	100.0%

7. Were the objectives for the lesson and test clear?

Response	Number	Percent
Yes	391	98.0%
No	9	2.0%
	400	100.0%

8. Did the course and unit descriptions give you enough information on what the course or lesson/test covered?

Response	Number	Percent
Yes	385	96.7%
No	15	3.3%
	400	100.0%

9. Was the information in the tutorial and the response items adequate to hold your interest in the lesson?

Response	Number	Percent
Yes	369	93.2%
No	31	6.8%
	400	100.0%

10. Were the terminals available when you wanted to take a lesson or test?

Response	Number	Percent
Yes	88	22.0%
Most of the time - some problem	258	64.5%
No, difficult to get on the system	54	13.5%
	400	100.0%

11. How would you rate the worth of the computer lessons/tests in achieving the objectives and information in the course?

Response	Number	Percent
Very beneficial	283	70.9%
Contributed some	103	25.8%
No better than the text	13	3.0%
Did not help much if at all	1	.3%
	400	100.0%

12. Did the computer lessons help you remember the material taught in the course better than a text or traditional lecture presentation?

Response	Number	Percent
Yes - CAI better	307	77.1%
No - test/lecture better	29	7.3%
No major difference	64	15.6%
	400	100.0%

13. Did your eyes bother you as you took a lesson or test? (Is viewing the screen a problem?)

Response	Number	Percent
Yes	110	27.4%
No	290	72.6%
	---	------
	400	100.0%

14. Was the response rate from the computer a problem in moving through a lesson or answering test questions?

Response	Number	Percent
Yes	57	14.3%
At times very slow (5-10 seconds)	268	67.0%
No major problem	75	18.8%
	---	------
	400	100.0%

15. How would you rate the quality of the tutorial lessons and test items?

Response	Number	Percent
Very good	149	37.4%
Above average	184	46.2%
Average	63	15.3%
Poor	4	1.0%
	---	------
	400	100.0%

16. Was the readability of the material suitable?

Response	Number	Percent
Yes	322	80.7%
No	78	19.3%
	400	100.0%

17. Did the PHOENIX lessons/tests help you learn more than traditional instruction?

Response	Number	Percent
Yes, PHOENIX raised my learning	284	71.2%
About the same as traditional	111	27.6%
No, PHOENIX held me back	5	1.3%
	400	100.0%

18. Do you feel that PHOENIX helped you enough that it should be maintained as a valid instructional tool?

Response	Number	Percent
Yes, keep and use	368	92.2%
No opinion	27	6.5%
No, drop and go back to the traditional instruction and testing	5	1.3%

19. Did you like to take lessons/tests on the computer?

Response	Number	Percent
Yes	374	93.7%
No	26	6.3%
	---	---
	400	100.0%

20. For final exams, would you prefer traditional teacher administered exams at the end of the quarter or monitored computer administered exams when you are ready to take them?

Response	Number	Percent
Teacher tests at end of quarter	102	25.5%
Computer tests on student demand	164	41.0%
No opinion -- either Ok	134	33.5%
	---	---
	400	100.0%

21. Did using the computer for instruction make you feel like you were wasting time?

Response	Number	Percent
Yes	28	7.0%
No	372	93.0%
	---	---
	400	100.0%

22. Did you feel that the lessons were personalized enough for you?

Response	Number	Percent
Yes	310	77.5%
No	22	5.5%
No opinion	68	17.0%
	400	100.0%

23. Did you at any time feel threatened by the computer as you were taking a lesson or test?

Response	Number	Percent
Yes	37	9.0%
No	363	91.0%
	400	100.0%

24. Should the use of the PHOENIX for supplemental instruction be required for class instruction or should it be made optional at student request?

Response	Number	Percent
Required -- good help to me	253	63.2%
Good experience but not much help to me	16	4.0%
Optional -- preferred to learn another way	81	20.3%
No opinion -- could live with it either way	50	12.5%
	400	100.0%

25. In general, how would you rate the use of computers (PHOENIX in particular), for learning new information?

Response	Number	Percent
Very beneficial	344	86.1%
No better than traditional systems	50	12.4%
Not as good as traditional texts/materials	6	1.5%
	400	100.0%

26. How would you classify your learning ability?

Response	Number	Percent
Very high	90	22.3%
Above average	213	53.4%
Average	91	22.8%
Must work very hard to learn	6	1.5%
	400	100.0%

27. Did you spend more time studying when you used PHOENIX than in other classes with traditional instruction?

Response	Number	Percent
More time with PHOENIX	165	41.1%
About the same time	137	34.3%
Less time with PHOENIX	98	24.5%
	400	100.0%

The following mean scores were recorded on data entered into the system by the information forms or from records in the PHOENIX archived data files.

Actual time spent on each lesson	29.15 minutes
Actual time spent on each test	15.05 minutes
Estimated lesson time by student	17.76 minutes
Estimated test time by student	6.29 minutes
Total LESSON time spent on each course	6 hrs. 6 minutes
Total TEST time spent on each course	4 hrs. 31 minutes
Total CBE time for each student per course	9 hrs. 44 minutes
Average number of CAI sessions per student	18.4 entries
Average number of Test sessions per student	42.5 entries
Average total number of entries per student	59.4 entries
Average age of the students in the study	22.22 years
Youngest age of student in the study	18
Oldest age of student in the study	50
Average course grade for students in class	3.30 (B+)
Average estimated GPA of students in study	3.17 (B)
Average GPA gain for CBE students in study	.13 GPA
Average pre-test score for total group	63.3%
Average post-test score for total group	93.8%
Average achievement gain per student/course	25.1%
Average pre-test for experimental group	53.28%
Average post-test for experimental group	87.59%
Average achievement gain for exper. group	34.31%

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